OBJECT LESSONS IN BOTANY

FROM FOREST, FIELD AND GARDEN.

BOOK I.

BY E. SNELGROVE, B.A.

LONDON: JARROLD AND SONS.

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From Forest, Field, and Garden.

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OBJECT LESSONS IN BOTANY

FROM

FOREST, FIELD, & GARDEN.

A First Botany Book for Teachers of Little Students.

(Standards I. and II.)

BY

EDWARD SNELGROVE, B.A.

S.C.E.R.T., West Bengal
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"You shall see mine orchard, where, in an arbour, we will eat a last year's pippin of mine own graffing."

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PREFACE.

THE following thirty-three lessons are specially intended to form an introduction to Botany as a Class Subject in Schools. Nevertheless it is hoped that they may also be of some service to those who prefer another but more general course of Elementary Science.

Botany, rightly taught, is the most purely pleasurable of the Sciences; and none can be compared with it for the scope it affords to cultivate habits of observation, or in respect to the accessibility of its objects of study.

So far as I am aware, there is no text-book of Botany which meets the demands of all the classes of an elementary school. The majority of botany books begin either with *cells* and *vessels*, or seek to interest the learner with the characters and functions of flowers. Neither of these courses is suitable to young children. Surely the right way is to begin with those things that first come under children's notice and in which they take a lively interest,—apples, oranges, plums, garden vegetables, cocoa-nuts, &c. This is the plan that has been attempted in this little book, and it is proposed to proceed in another to the next most easily observable features of plants, viz., the forms and characters of leaves, stems, and roots, leaving the consideration of flowers to the next stage. This is identical with the plan laid down in the Alternative Course C of Elementary Science in the present Education Code.

I have preferred to err (if at all) on the side of excess, knowing that excision is easier than insertion. The lessons are all the result of practical experience. The guiding principle I have kept before me has been to proceed "from the known to the unknown"—from the more to the less familiar—and not only so in the choice of subjects, but in the order in which they are placed, and in the method of treatment; the essential features being:—

1. The cultivation of the habit of observation.
2. The registration of the results of that observation.
3. The formation by those means and by reasonable inductions of a fund of knowledge.
4. The maintenance of a lively interest in the operations of nature and the part played by human labour.

Technicalities have been generally avoided.

There is no pretence to originality; the subjects are old, but their treatment, I hope, is such as will make the book an aid to busy teachers, a guide to young teachers, and a means of opening up pleasant paths to little students.

E. S.

Heeley, Sheffield.
February, 1894.

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OBJECT LESSONS

From Forest, Field, and Garden.

I.

AN APPLE.

Apples, leaves and flowers (or picture).

APPEARANCE.

1. Show apples to the children and lead them to notice the following :—

(*a*) The colour—green or red.
(*b*) The size—about as large as a boy's fist or a cricket ball.
(*c*) The shape—nearly round, hollowed at the top and bottom.
(*d*) The stalk—by which they are fastened to the tree.
(*e*) The rough portion in the hollow at the top.

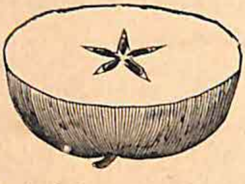

Fig. 1. Apple in section. Showing the five cells containing pips.

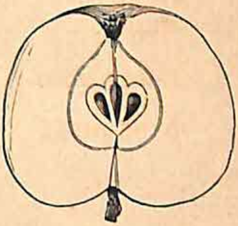

Fig. 2. Vertical section of an apple.

STRUCTURE.

1. Cut an apple horizontally through the centre, and exhibit the sections to the class. If you have sufficient, distribute half an apple to every two children, and lead them to observe :—

(*a*) The star-shaped centre of 5 rays.
(*b*) The pulp or part that is eaten.
(*c*) The outer covering or skin.

2. Draw attention to the centre or *core*. Let the children take out the *pips*. If these are dark-brown or black, the apple is ripe. Lead the children to tell :—

(*a*) The pips are the seeds.
(*b*) They are held in 5 cells.
(*c*) The cells are made of hard scales.

3. Cut an apple vertically through the centre (Fig. 2). Let the children take out and examine the scales of the cells :—

(*a*) The scales are like those of a fish, and are unpleasant to eat. They are generally thrown away.
(*b*) They serve as a protection to the seeds.
(*c*) They are entirely surrounded by the pulp.
(*d*) The pulp is covered by a thin but tough skin.
(*e*) The skin keeps the pulp from being dried or injured by the weather.

The skin however is not strong enough to withstand the attacks of insects. One, the apple moth, lays its eggs in the apple. When hatched, the young caterpillar bores its way into the apple. Children will have sometimes seen what they call worms in apples.

4. Cut a pip and notice :—

(*a*) It consists of an outer skin and an inside white portion.
(*b*) The white portion is bitter to the taste.

THE APPLE TREE.

1. If the pips or seeds were sown, young apple trees would grow up. Some might be sown in a pot in the schoolroom window.

2. When are apples ripe on the tree? *In autumn.* What come before the apples? *Flowers or blossoms.* The blossoms appear in spring almost before the leaves burst from the buds.

3. *If possible*, show some blossoms and leaves; draw attention to :—

(*a*) The colour—pinky white.
(*b*) The general resemblance to wild roses.
(*c*) The small hard lump under the flower.

This hard lump is that which will grow to be an apple when the flower has fallen away.

4. Let the children again look at their apple, and notice the rough portion at the top. Compare with a small apple (if one can be had) and lead the children to see that it is the remains of the flower.

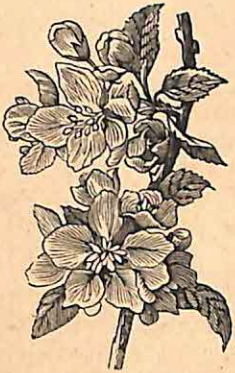

Fig. 8. Apple blossom.

Apple blossoms are very beautiful. An apple tree in flower is a splendid sight. The tree is very irregular in form and about 20 feet in height.

USES.

1. *For food.* Uncooked apples should not be eaten unless they are ripe. Let the children compare a ripe and an unripe apple.

(*a*) The unripe apple is sour to the taste.
(*b*) Its pips are white.

No fruit is more wholesome and none can be kept so long.

2. *For making cider.* Large orchards are grown in the west of England for this purpose.

3. The apple contains the seeds which will produce other trees.

GRAFTING.

Wild apples are called crabs. They are small and sour.

The trees that grow from apple pips produce crabs unless they have been grafted. This consists in cutting off the stem of the young tree and fastening in its place a branch from a good apple tree in such a way that this branch in time grows fast to the stock and forms part of the tree. Then the tree will bear apples.

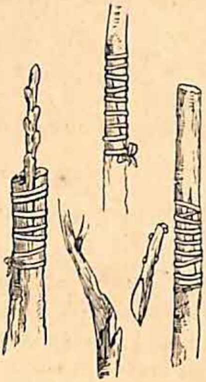

Fig. 4. Modes of grafting.

SUMMARY.

1. An apple consists of *skin*, *pulp*, *and core*.
2. The core is scaly and contains the seeds.
3. The seeds will produce other apple trees.
4. The trees must be grafted before they will bear apples.
5. Wild apples are called crabs.
6. The apple tree bears blossoms in the spring.
7. The blossoms are followed by the apples which are ripe in the autumn.
8. Ripe apples are most wholesome food.

II.

PLUMS & CHERRIES.

Plums of several kinds (including damsons), prunes, cherries if possible.

It is hardly likely that both plums and cherries can be obtained at the same time.

INTRODUCTION.

1. Show different kinds of plums, name them, and question on their uses.

2. Lead the children to tell:—

(*a*) Plums always contain a stone.
(*b*) For this reason they are called *Stone fruit.*

DESCRIPTION.

Select typical plums in turn and get the children to tell that they are:—

(*a*) In *colour*, green, red, or dark coloured.
(*b*) When not handled covered with a *bloom.*
(*c*) In *size*, smaller than an apple (generally).
(*d*) In *shape*, sometimes round but oftener oblong.
(*e*) To the *touch*, smooth and softer than an apple.
(*f*) Attached to a stalk. Often the stalk is absent, but the place where it has been can be seen.
(*g*) Without a dry withered part at the top.
(*h*) In some instances *furrowed* down one side.

PARTS OF A PLUM.

1. Cut longitudinally a ripe plum and lead children to notice:—

(*a*) The stone in the centre.
(*b*) The soft juicy pulp.
(*c*) The thin skin surrounding the pulp.

2. In an unripe plum the pulp is not easily detached from the stone. Notice the small fibrous attachment of the stalk to the stone. What can be the use of this? We shall see presently.

3. Have some prunes soaked and show:—

- (*a*) Prunes are of the same size as some plums.
- (*b*) They each contain one large stone.
- (*c*) The stones are surrounded by a soft pulp.

4. Show dried specimens and notice the withered wrinkled surface. What are these prunes? They are *dried plums*—dried to preserve them for a longer time than it would be otherwise possible to keep them. They are often called *French plums.*

THE STONE.

1. Let the children examine a plum stone and notice:—

- (*a*) It is hard and rough, too hard to be broken by the teeth.
- (*b*) It is much flattened, with rather sharp edges.

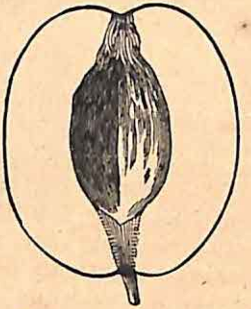

Fig. 5. Plum, showing stone in position.

2. Break a plum stone. Some may be divided into two parts with a knife:—

- (*a*) The stone contains a kernel.
- (*b*) The kernel is brown outside, white inside.

3. What is this kernel? If we were to put it in suitable ground a plum tree would grow from it. (In doing so the stone should not be broken, the young plant would open the decaying stone.)

- (*a*) The kernel is the seed of the plum tree.
- (*b*) The stone protects it from being destroyed.

4. Let children taste the kernel. It is bitter. The bitter taste is due to the presence of a very small quantity of a

poisonous substance which can be extracted and is then called Prussic Acid.

FOR WHAT PURPOSE DOES A PLUM GROW ON A TREE?

The question is not "What do we grow plums for?" But, why do they grow on the tree at all? Let us consider a little.

1. What is the use of the stone?

To hold and protect the seed.

2. Now what can be the use of the pulp? Suppose the stones grew without pulp, who would gather them?

Probably nobody.

3. And what would happen to them when they were quite ripe?

They would fall to the ground.

4. Where?

Underneath the tree.

5. And what would grow from them?

Young plum trees.

6. But if all the stones fell underneath the tree, the young plants would be very much crowded together; then how would they grow up?

They would hinder one another's growth.

7. Yes; they would entirely destroy one another. But as there is a nice juicy pulp round the stone it is not left to fall off. What happens?

We gather them.

8. And if we do not, what then?

The birds take them and eat them.

9. Now in either case, whether people or birds take them, what becomes of the stones?

They are thrown away.

10. Where?

In all kinds of places.

11. And if young plants grow from them it will not be under the old tree, but in various places far and wide. In which case are the young trees likely to be better and stronger, crowded together under the old tree or scattered abroad?

Scattered abroad.

12. And what is it that scatters them abroad?

The birds (or people).

13. Why do people or birds take them?
They want to eat the juicy pulp.

14. If there were no juicy pulp what would they most likely do.
Leave them alone.

15. What then causes the seeds to be taken far away from the parent tree?
The juicy pulp.

16. If it is better that seeds should be taken far away, and we see that no one would take them unless he wanted the pulp, what is the purpose for which the pulp grows round the stone?
To persuade birds and people to take the plums so that the seeds can be scattered about.

17. Suppose there were no strong covering to the seed inside the pulp, what then might happen?
The seed would most likely be eaten with the pulp.

18. Let us then summarize :—
(*a*) The plum contains a seed from which another tree can grow.
(*b*) The pulp induces people to take the fruit so that the seeds may be scattered.
(*c*) The stone prevents the seed from being eaten.
Now what is the chief purpose for which a plum grows on the tree?
To produce seeds so that new trees may grow.

19. And in doing this what does it do for us at the same time?
Gives us food.

20. Yes; the tree gives us food, and we in return do something for it?
Scatter its seeds.

CULTIVATION:

In a wild state plums grow very small. It is believed that some of our plums are produced from the *sloe* or *blackthorn*, which has very small and bitter fruit. Great care in growing and grafting has caused the plums to grow larger. Like apple trees all plum trees must be grafted.

THE CHERRY.

(*The following may be added at the teacher's option in a lesson of revision.*)

1. Compare a cherry with a plum.
    - (*a*) It is smaller and rounder.
    - (*b*) It has the same parts, skin, pulp, stone.
    - (*c*) It is therefore a *stone* fruit.
    - (*d*) The stone is more firmly attached to the stalk.

2. Lead the children to see that it is through this attachment that the growing seed is fed.

PLUM AND CHERRY TREES.

1. Both are woody trees, the cherry the taller—15 to 20 ft. high or more.
2. Both bear beautiful white flowers in spring.
3. Cherries grow in pretty bunches.
4. The cherry, like the plum, must be grafted or it will be wild.
5. Both exude *gum* from the bark.

III.

PEACHES & ALMONDS.

A peach; almonds in shell, sweet and bitter almonds, oil of almonds. (*The last two are poisonous.*)

THE TREE.

Show a peach, note its general resemblance to an apple, give its name and a brief description of the tree.

The Peach tree is not a native of England; it grows in warm climates. If grown in England it must be planted in a greenhouse. Occasionally in the south peaches are grown in the open air. They are trained against walls.

A PEACH EXAMINED.

1. Let the children carefully examine the fruit with regard to various points suggested. They should tell:—

(*a*) The peach is round or *globular*, and of the size of an apple.
(*b*) It is red-cheeked when ripe *like* an apple.
(*c*) It is covered with soft down *unlike* an apple.
(*d*) It has a furrow down one side *like* some plums.

2. Cut open the peach longitudinally, and get the children to tell the parts they see :—

(*a*) There is a stone in the centre.
(*b*) The stone is surrounded by a juicy pulp, and this is covered by a skin.
(*c*) Inside it is very much like a *plum*.

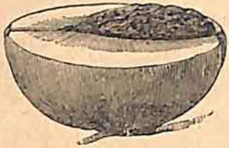

Fig. 6. Peach cut to show position of the stone.

3. Let some taste the pulp; it is sweet and has a very nice flavour. Such a flavour is said to be *delicious*. By some people the peach is considered the most delicious fruit cultivated in England.

THE STONE—ALMONDS—WHAT THEY ARE.

1. Notice the shape and size of the peach stone :—
It is a large stone, long, flat, and rough.

2. Show some almonds in "shell." Notice the similarity between peach stones and almonds.

3. Break one of each and show the kernels. Clean off the outer brown coating after first scalding with hot water. What do these now look like? The almonds eaten with raisins. Yes, the white almonds have been taken from the shells, and their brown coverings removed.

4. But the almonds in the shells, what are they? They are the stones of fruit much like peaches. The almond tree bears fruit the pulp of which dries up and then bursts, showing the stone.

5. Summarize :—

- (*a*) Peach stones and almonds are much alike in shape and size.
- (*b*) Each contains a kernel.
- (*c*) The kernels of almonds are cleaned and eaten.
- (*d*) An almond is the stone of a fruit like a peach.
- (*e*) We eat the *pulp* of the peach, but the *kernel* of the almond.
- (*f*) Peaches and almonds are *stone fruit.*

6. What are these kernels? What were the kernels of plum stones found to be? Seeds. These are also seeds. And from them, if sown in the shells, peaches or almonds would grow.

OIL OF ALMONDS.

1. Let the children smell some of this oil. Its odour is very pleasant. Tell them that it is extracted from bitter almonds, which are poisonous.

2. Recall what was said of the kernels of plum stones. The same poison—Prussic Acid—is here present in larger quantity.

Caution against the excessive use of this oil. It is used as a flavouring for puddings and sweetmeats, and a single drop goes a long way. Death has been known to follow a dose of a few drops.

IV.

BERRIES.

Ripe and unripe gooseberries ; red currants, black currants ; grapes, raisins, currants ; leaves on stems from trees of each of the above fruits.

A GOOSEBERRY.

1. Give out gooseberries to children, and by suitable questions lead them to tell the following :—

- (*a*) Gooseberries are oblong in shape.
- (*b*) They are hard, but become soft when ripe.
- (*c*) Some are smooth, some hairy.
- (*d*) Each has a stalk, and, at the top, the remains of the flower. (*Compare with the apple.*)

2. Cut each gooseberry transversely and show :—

(*a*) The skin thick, enclosing the pulp.
(*b*) The pulp is not hard, but juicy.
(*c*) The seeds are embedded in the pulp.

3. Make a sketch on the black board to show how the seeds are attached to the walls or skin.

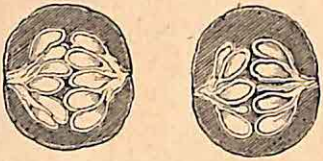

Fig. 7. Gooseberry cut in two.

4. Let the children notice the *sour* or *acid* taste, especially when the fruit is not ripe.

5. Explain that a juicy pulp, like that of the gooseberry or plum, is said to be *succulent.*

Summarize :—

(*a*) The gooseberry has a succulent pulp.
(*b*) In this pulp seeds are embedded.

Such a fruit is called a *berry*. Lead the children to define a berry by combining the two above statements.

RED AND BLACK CURRANTS.

1. Show specimens of both. Notice the pretty tassels of red currants. Distribute specimens and lead the children to observe :—

(*a*) Red currants are smaller than black.
(*b*) Both are smaller than gooseberries.
(*c*) Both are round or globular and quite smooth.
(*d*) Both have stalks and the remains of the flower at the top.

2. Carefully cut the thin skin of two or three specimens, and show :—

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(*a*) The skin is filled with a juicy pulp.
(*b*) Several small seeds lie in this pulp exactly as in the gooseberry.
(*c*) Currants are also *berries*.

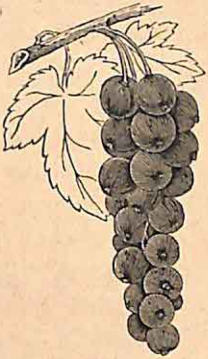

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Fig. 8. Raceme or tassel of red currants.

GRAPES.

1. Show a bunch of grapes. Notice its shape and the beauty of its form. Take off some grapes and lead children to examine them carefully as above :—

(*a*) In shape and size grapes are like gooseberries.
(*b*) But they are smooth, and nothing of the flower remains.
(*c*) They are filled with a juicy or succulent pulp in which the seeds are embedded.
(*d*) Hence grapes are *berries*.

2. Show the children that the so-called stones are seeds. What can be done with a stone? It can be cracked. What does it contain? A seed. These are the seeds themselves.

RAISINS AND CURRANTS.

1. Have some soaked raisins ready. Show some dried raisins. Lead children to observe :—

(*a*) The skin is dry and shrivelled.
(*b*) It contains a succulent pulp.
(*c*) Stones or seeds like grape-stones are embedded in the pulp.

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2. Compare with the soaked raisins.
   - (a) Raisins are about as large as grapes
   - (b) Their seeds are like those of grapes.
   - (c) But they are dry.

3. Tell the children that raisins are dried grapes. Grapes cannot, like apples, be kept a long time in the state in which they are gathered, they must be preserved. How are plums preserved? By keeping them in air-tight bottles, or by boiling them with sugar. Ask for other fruits so preserved. Grapes, however, contain enough sugar to preserve them. They only need drying. This is done in various ways. In some places (Spain especially) the grapes are partially cut from the tree and allowed to dry in the sun.

4. Currants are also dried grapes of another kind that grow in and about Greece, in a wild state.

THE TREES FROM WHICH ALL THESE FRUITS COME.

Show specimens of the different plants first, to get from the children the following observations:—

- (a) The gooseberry tree is noted for its spines.
- (b) The currant trees (especially the black) have a fragrant smell. Both are small shrubs.
- (c) The grape grows on a vine. Vines are climbing plants, rising by *tendrils*.

USES.

All are eaten as food. Currants and gooseberries are preserved. Grapes are grown largely in France for making wine. In England they generally grow in greenhouses.

V.

ORANGES.

(THE GOLDEN APPLES OF THE HESPERIDES.)

Oranges, candied peel, oil of orange, dried orange peel.

ABOUT ORANGES GENERALLY.

1. Show an orange to the class. Ask a few questions about the sweet taste of oranges, where they grow, and the different kinds. Add to what they know.

   (*a*) Oranges grow in warm countries.
   (*b*) They are brought to us chiefly from Spain and the West Indies.
   (*c*) Oranges will not ripen in England except in an orange or hot house.

2. Tell of or show some of the different kinds.

   (*a*) Seville oranges (Spain)—bitter.
   (*b*) St. Michael ,, —sweet.
   (*c*) Maltese (Malta)—red inside.
   (*d*) Jaffa (Palestine)—large.

THE OUTSIDE OF AN ORANGE.

Question on the external characters, and so get from the children:—

(*a*) An orange is globular in shape and of about the size of an apple.
(*b*) It is soft and smooth to the touch.
(*c*) Its surface is full of little holes.
(*d*) It has a very pleasant odour.

THE INSIDE.

1. Cut an orange through the middle horizontally and show the arrangement of the parts. Question the children as to what these parts are:—

   (*a*) It consists of a thick peel or rind and a juicy pulp.
   (*b*) In the pulp there are *pips* or *seeds*.
   (*c*) The pulp is divided into 8 or 10 parts.
   (*d*) These parts are broad towards the outside and narrow in the middle of the orange.

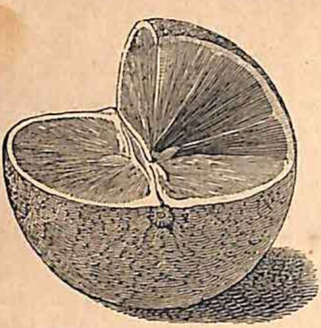

Fig. 9. Orange cut to show structure.

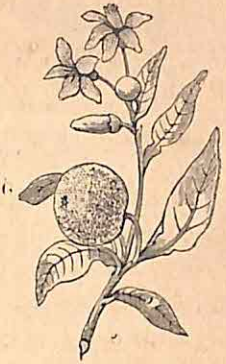

Fig 10. Orange branch, bearing leaves, flowers, and fruit.

2. Call attention to the position of the seeds—embedded in the pulp. What fruit have we described in which the seeds were so placed? A gooseberry, a grape, a currant. What did we call such fruits? Berries. What then is an orange? *A berry.*

"QUARTERS."

1. Take another orange and remove the peel. Notice how easily it can be taken off. Compare with apple. The skin of the apple could only be removed with a knife, and then some of the pulp was taken with it. We shall see the reason for this difference in a moment.

2. Separate the parts of the orange. What are these called? Quarters. How many are there then? Eight (or ten). How many quarters can there be in one thing? Four. Then these are not real quarters, they are eighths (or tenths).

3. Lead the children to examine these parts:—

(*a*) Each part is covered with a thin skin.
(*b*) This skin is tough and semi-transparent.

When we peel an orange we do not separate the rind from the pulp (as in the apple), but from the thin skin which covers each part. This skin should not be eaten.

4. Examine the pulp.

(*a*) It consists of little vessels or sacs.
(*b*) Each sac contains a thin juice.
(*c*) This juice has a *sweet* and an *acid* taste.

When the orange is not ripe there is little of the *sweet* and much of the *acid* taste. It is the combination of the sweet and the acid which make the juice of the orange so refreshing.

THE SEEDS OF THE ORANGE.

1. What are the pips we find in an orange? Seeds. Then what is their use? To produce new trees. Some might be sown in a pot in the school window.

2. Let us examine them more closely :—

(*a*) They are larger than those of the apple.
(*b*) They are very hard and slippery.

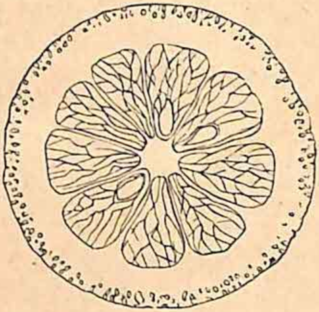

Fig. 10 A. Horizontal section of an orange.

Cut through the outer coat :—

(*c*) The outer coat is very tough.
(*d*) Within they are white in colour and bitter to the taste.

ORANGE PEEL.

1. Orange peel is sometimes thrown on the ground. Suppose you set your foot on a piece, what happens? Caution against the dangerous practice.

2. Observe :—

(*a*) The colour is reddish yellow—called orange.
(*b*) It is white and spongy inside.
(*c*) Outside the surface is rough.

3. Demonstrate the following:—
    - (*a*) The sharp *taste* of the peel.
    - (*b*) Its pleasant odour.
    - (*c*) The glossiness of it when rubbed.
    - (*d*) Its softness to the touch.
    - (*e*) The readiness with which it burns when dried.

Squeeze a piece before a light. Notice that something burns.

Show some oil of orange. This is extracted from orange peel. What then was it which burned in the light? Oil.

What was it which caused the dried peel to burn so well? Oil. Yes, and it was also the oil which was the cause of its smoothness and glossiness.

Let the children smell the oil. What is it like? It smells like the peel of the orange. Then what gives the orange peel its odour? The oil it contains. Yes, and it is also the same oil which gives to it its sharp taste.

THE ORANGE TREE.

Give a brief description of an orange grove. The trees grow to about twenty feet in height, and have dark evergreen leaves not unlike those of the laurel. The flowers are beautifully white. Flowers, green and golden fruit may all be seen at the same time, on the same tree, for the fruit requires *two years* to come to maturity. Generally it is gathered green for exportation; it ripens on the voyage. As many as 20,000 oranges have been taken from one tree in a year.

USES.

1. As a luxury and as a food.

2. The peel is candied by being soaked in brine and preserved in syrup of sugar—candied peel.

3. Oranges are also preserved in the form of marmalade.

4. From the juice orange wine is made.

5. Oil is extracted from the peel; another oil from the leaves, and still another from the flowers.

VI

FRUIT.

(A Summary with Additions.)

An apple, plum, grapes, and specimens of preserved fruits.

WHAT IS FRUIT?

1. Refer to the subjects of the preceding lessons. What name might we use to speak of apples, pears, plums and oranges? *Fruit.*

2. Now let us see what we mean by the word *fruit.* Where do we get apples from? From trees. And all fruit, where are they obtained? From trees. Ask for names of fruits children have seen growing on trees.

3. What have you noticed grew on the tree before the fruit appeared? *Flowers.* Yes, flowers or blossoms. Now tell me exactly in what place the fruit grows on the tree? In the place where the flower has been. Unless there has been a flower you will never find fruit.*

4. Think of all the fruits we have talked about. What did you find in each of them? *Seeds.*

5. We have now found out three things about fruit; let us write them down:—

(*a*) Fruit grows on trees (or plants).
(*b*) Fruit always grows where a flower has been.
(*c*) Fruit contains seeds.

6. Now try to make up a definition from these three statements, that is, put them together in such a way as to tell me exactly what fruit is.

---

* This statement is of course limited to *flowering* plants. Ferns and mosses are *flowerless* plants.

Fruit is something which grows on a plant in the place of its flower and contains its seeds.

THREE FRUITS COMPARED.

1. Take an *apple*, a *plum*, and a *grape*. Lead the children to give the characters of each, and write them down thus :—

Apple	*Plum*	*Grape*
Pulp hard	Pulp soft	Pulp soft
Seeds in cells	One seed in a hard stone	Seeds in the pulp
(*Pome*)	(*Drupe*)	(*Berry*)

2. Tell the children that such a fruit as the apple is called by botanists a *pome ;* a plum is called a *drupe ;* and a grape a *berry.*

3. Ask for examples of each :—

(a) *Pome*—apple, pear.
(b) *Drupe*—plum, cherry, peach, almond.
(c) *Berry*—currants, gooseberry, orange, lemon, and grape.

USE AND PRESERVATION.

1. Fruit not only affords pleasant food when it is ripe, but it can be preserved for future use :—

(a) By boiling with sugar—plums, gooseberries, oranges, etc.
(b) By sealing up in air-tight bottles—plums, peaches, etc.
(c) By drying—plums (prunes).
grapes (raisins and currants).
apples (in rings) peaches.

2. In other ways a portion of the fruit is preserved :—

(a) By candying—the rind of oranges and lemons.
(b) By fermentation—the juice of apples, grapes, and oranges.
(c) By extracting the oil—oil of orange.
(d) The dried seed—almond.

VII.

STRAWBERRIES.

Strawberries, leaves and runners, wild strawberries (if possible). Fruit of the common buttercup.

THE OUTSIDE OF A STRAWBERRY.

1. Distribute as many specimens as possible. Ask questions about the use of the strawberry, its taste, flavour, etc.

2. Proceed to an external examination of the fruit. Lead the children to notice the following points:—

(*a*) In colour it is red when ripe.
(*b*) In shape conical.
(*c*) It is quite soft to the touch. It will not bear pressure.
(*d*) There is a ring of little leaves at the base, and a few dried thread-like remains.
(*e*) The surface is dotted over with small hard bodies.

The children should recognize the *remains of the flower* at the base of the fruit.

THE INSIDE.

Cut through some of the specimens:—

(*a*) The inside consists of a soft, pinky-white juicy pulp.
(*b*) The pulp contains no seeds
(*c*) There are small string-like attachments going to the hard bodies on the surface.

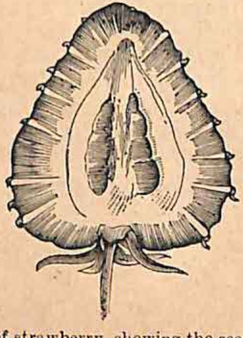

Fig. 11. Section of strawberry, showing the seeds on the outside.

THE SEEDS GROW ON THE OUTSIDE OF THE FRUIT.

1. Show the children the fruit of a buttercup. By squeezing it between the finger and thumb, separate the small hard bodies of which it is composed. Notice their shape. Each one contains a seed which may easily be seen.

2. Compare these small hard bodies with those on the outside of the strawberry. These each contain a seed. Thus the seeds of the strawberry grow on the outside; or rather, the pulp, instead of growing round the seeds as in the *apple*, grows in the centre and pushes out the seeds on its surface.

THE STRAWBERRY NOT A BERRY.

1. Recall the characters of a berry—a juicy fruit having the seeds embedded within the pulp.

2. Hence show:—

   (*a*) The strawberry is not a real berry.
   (*b*) Nor is it a *drupe* or a *pome*.

USE.

1. Let children smell and taste the fruit:—

   (*a*) It has a very pleasant odour.
   (*b*) Its taste is sweet, with a slight sourness.
   (*c*) It has a very delicious *flavour*.

2. There is no fruit grown in the open air in our climate so delicious as the strawberry. It possesses little nutriment (that is little value as a food)—less than any of the fruits we have so far spoken of.

RUNNERS.

1. Show specimens of leaves and stems. Explain how they grow. Instead of standing erect, the stems run along the ground and take root at the knots. Here they send up leaves, and at every knot a new plant is formed, which may be cut off from the parent plant.

2. Summarize:—

(*a*) The strawberry plant has a running stem.
(*b*) New plants are grown from the runners.
(*c*) The leaves are each divided into three.

NAME.

1. Some people think the name is formed from *straw* because it is usual to place straw under the plants to keep the fruit from the ground.

2. It is more likely the plant gets its name from its habit of growth. Allude to its wandering character. What is a sheep (for instance) said to do when it wanders from the rest of the flock? It *strays* away. Yes, and this plant *strays*. So strawberry probably means strayberry.*

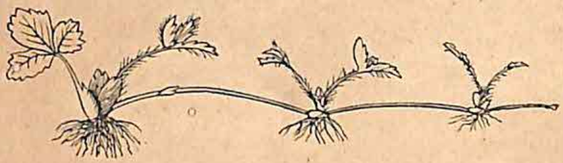

Fig. 12. Runner of strawberry rooting at the nodes.

A single leaflet

CULTIVATION.

1. Show some wild strawberries if possible. If not, allude to them or describe them. Some of our garden strawberries are but cultivated varieties of these. Some have come to us from America. In no country, however, is the flavour so delicious as in England. What the peach and pine apple are to other lands, the strawberry is to England.

* "Strabery ripe and cherryes in the rise."
London Lyckpeny (1420).

VIII.

RASPBERRIES & BLACKBERRIES.

> "Thy fruit full well the schoolboy knows,
> Wild bramble of the brake,
> So put thou forth thy small white rose,
> I love it for his sake."—*Elliot*

Ripe and green blackberries, bramble and flowers;
Raspberries, canes, and underground stems.

THE TWO FRUITS COMPARED.

1. Show specimens of both fruits. Ask for their names. Question out the following facts:—

(*a*) Raspberries are grown in gardens, though sometimes they are found wild.
(*b*) Blackberries grow on brambles, which are always wild.
(*c*) Both plants are prickly.

2. Cultivation has improved both the size and flavour of the raspberry; not so the blackberry.

3. Cause the children to examine closely the two fruits and to observe:—

(*a*) Both fruits are about equal in size—one red, the other, black.
(*b*) Each is made up of a number of small parts, closely grown together.
(*c*) Each fruit has the remains of the flower at its base.

STRUCTURE OF THE FRUIT.

1. Give specimens to the children. Let them carefully separate the parts of which the fruit is formed.

Observe:—

(*a*) Each part is like a little fruit in itself.
(*b*) Each part has a hard seed in the centre.

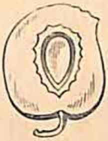

Fig. 13. Single drupel of a blackberry.

Explain that this is a little stone containing a seed. Show by drawing on the blackboard.

2. Which then of the fruits we have examined does this little part most resemble? A plum. And what did we call a plum? A *drupe*. Yes. What then is a blackberry made up of? Several little drupes. So it is not quite correct to call it a *berry*; but *black-berry* is the name that has been given to it, and the name by which it will always be known. So with a raspberry.

BRAMBLES AND CANES.

1. Show specimens of brambles and leaves. Question on the habit of growth. Observe the prickles and their shape:—

(*a*) The stems are slender and straggling, often straying over hedges and walls.
(*b*) They are covered with strong hooked prickles.

2. Consider whether these prickles have any special use. What would happen to any one who attempted to break down or destroy a bramble? He would get well scratched. Knowing that, what would anyone be likely to do? Leave it alone. Then think how the bramble grows amongst the hedges, and how slender its stem is, what use may these prickles be to the stem? They may help to hold up the stem. Therefore:—

(*a*) The prickles serve as a means of defence.
(*b*) They help to hold up the slender stem.

3. Show leaves and canes of raspberry. Observe:—

(*a*) The stem is quite erect.
(*b*) It is covered with short prickles.

(*a*) Pea pods are smooth.
(*b*) Bean pods are hairy or downy.
(*c*) Kidney bean pods are rough, but not hairy or downy.

PLANTS AND FLOWERS.

1. Show specimens of flowers. Notice the general resemblance in shape :—

(*a*) The flowers are all butterfly shaped.
(*b*) Those of peas are white.
(*c*) Of the bean, black and white.
(*d*) Of the kidney bean, scarlet or white.

2. Show the method or habit of growth of the stems.

(*a*) The bean has a short erect stem.
(*b*) The pea, a trailing slender stem, which gains support by tendrils.
(*c*) The kidney bean or scarlet runner twines itself round sticks or poles.

THE FRUIT IN DETAIL.

1. As in the case of the pea, all these pods follow flowers. What do they contain? Beans or peas. What might be done with them when ripe? They might be sown. What then are they? Seeds. What are the pods containing the seeds? They are the *fruit*.

2. Open the pods and notice the contents :—

(*a*) The seeds are fastened to the pods by little stalks.
(*b*) The inside of the bean pod is woolly.

USE.

1. Question on the parts used as food.

(*a*) Of peas and broad beans we eat the *seed*.
(*b*) Of kidney beans we eat the whole *fruit*, while the beans are still young.

Haricot beans are the ripe seeds of French beans.

2. Peas and beans are called *Pulse*. They form the most nourishing of all foods.

Dried peas contain 90 parts of nourishment out of 100.

Beef contains 35 parts of nourishment out of 100.

3. Explain this statement, and recapitulate.

X.

MUSTARD.

Mustard, seeds, the same in pod, plant in flower (or the common yellow flowering weed of ploughed land), some young plants. To get the last, sow some seeds on a wet flannel or piece of wadding on the top of a jar of water, about a week beforehand.

PRODUCTS.

1. Refer to the condiment mustard. Question on its uses and properties.

(*a*) It is a yellow powder.
(*b*) It is very hot and sharp to the taste.

Such a taste is called pungent. It only acquires this hotness or pungency through being mixed with water.

2. Show seeds, and allow some children to taste them. Crush some.

(*a*) The taste of the seeds is hot or pungent.
(*b*) They are yellow inside, and can be crushed into a powder like mustard.

3. Tell that these seeds are mustard seeds, and from them mustard is obtained. What must be done to the seeds? They must be crushed or ground. What is the colour of the outside? Brownish-white or black. If this were ground up and left in the flour it would make it of a darker colour. It is sifted out after grinding.

4. Show some mustard oil. Explain that this oil is often crushed out of the seeds. It contains the hot principle of the mustard and it is often used for rheumatic. The remnant, after this crushing, is a hard brown cake, which is used for feeding cattle.

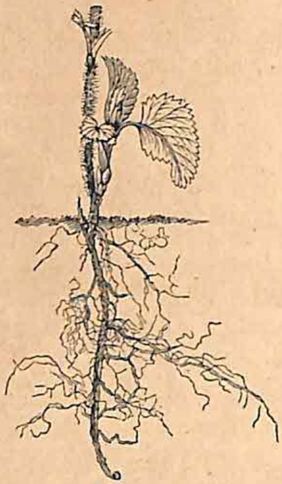

Fig. 14. Underground stem and roots of raspberry.

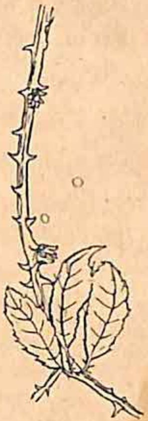

Fig. 15. Bramble stem, showing prickles.

It is the rough *rasping* character of the stem that has given the name to the plant.

4. Those who have seen raspberries growing in a garden will have seen what appeared to be young plants growing round about the old ones. If an attempt be made to pull up one of these it is found to be part of the old plant. It is attached by an *underground stem* similar to the *runner* of the strawberry. Sketch on black board to show the manner of growth. If possible, show a specimen.

FLOWERS.

1. These are found on the plant at the same time as both ripe and unripe fruit in late summer or autumn.

2. The flowers of the raspberry are *white*, those of the blackberry *pink* or *pale purple*.

3. Both resemble small roses.

4. Raspberries are ripe in July or August; Blackberries in September or October.

USES.

1. Both are used as food, cooked or uncooked.

2. Both are preserved by boiling with sugar.

3. From blackberries, wine is made; from raspberries, raspberry vinegar.

SUMMARY.

1. Brambles have long straggling prickly stems. The prickles serve as defence and support.

2. Raspberries have an upright stem, and a creeping underground one.

3. The fruits are collections of little drupes.

IX.

PEAS AND BEANS.

(PULSE.)

Dried peas, green peas, some soaked peas; some germinating, having been sown a week beforehand; pea flower.

DRIED AND GREEN PEAS.

1. Show specimens of dried peas. Ask what they are. Observe:—

(*a*) Peas are hard and dry.
(*b*) Round and smooth. Some are wrinkled.

2. What other form of pease have children seen? Green peas. Show examples in pod.

3. Open pod. Compare contents with dried peas. Children will soon tell that the dried peas have once been green.

WHAT PEAS ARE.

1. Ask whence the pods were obtained? They grew on plants.

2. Tell children that the pods were preceded by flowers. Show, if possible, some pea flowers. They are said to resemble, to some extent, a *butterfly*.

3. Open a flower, and a small pod will be found inside. Show pods in different stages of growth. Open, and let the little peas be seen.

4. Now where does the pea pod grow? In the place of the flower. And what does it contain? Peas. *What then are these pods?* The *fruit*. And the peas? They are seeds. Suppose we were to sow some dried peas, what might be expected to happen? Plants would grow from them.

ERMINATION.

1. Distribute specimens of soaked peas. Instruct the children how to take off the outer coat. Notice what follows.

- (*a*) The pea has an outer skin or covering.
- (*b*) Inside this there are two thick portions or halves.
- (*c*) Between these two halves is a little curled-up body.

2. Show specimens that have been growing a week. Then some that are grown still more. Observe:—

- (*a*) The little curled-up body has burst through the outer coat.
- (*b*) It has lengthened, one part going upwards, one part downwards.

3. Explain that this little curled-up body is a young plant contained in the pea. All seeds contain such a little plant as this, but it is not so easy to see it in all cases. The two thick halves contain food for the little plant to begin to grow upon. It will not grow without *warmth* and *moisture*.

THE FRUIT.

1. Show pea pods, and more carefully examine:—

- (*a*) The pod is long and narrow.
- (*b*) It is smooth and bright.
- (*c*) The peas are fastened to the edges of it inside.

2. Break the wall of the pod; notice :—
   - (*a*) The outer coat is thick and succulent.
   - (*b*) The inner is hard and semi-transparent.
   - (*c*) Such substance is called *membrane.*

3. This is the part that dries and causes the peas to be thrown out when the pod is ripe.

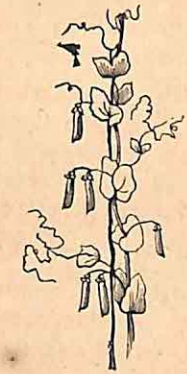

Fig. 16. Garden pea, leaves, pods, and tendrils.

IX. PEAS AND BEANS (*continued*).

Dried peas, beans, kidney beans (scarlet runners); the same in pod; Flowers, stems, and leaves of each.

PEAS AND BEANS COMPARED.

1. Show specimen of dried peas and beans. Sketch the outline shape of each on blackboard. Notice their colours :—
   - (*a*) Peas are round, and brown or greenish in colour.
   - (*b*) Beans are large, broad, flat and brown—called broad, or Windsor beans.
   - (*c*) The other bean is smaller, kidney shaped, and in colour black and pink.

2. Show specimens of peas and beans in pod. It is probable that kidney beans will not be obtainable at the same time as broad beans. If not, a description of such must suffice for the time. Compare the pods.

THE MUSTARD PLANT.

1. If then we sow these seeds, what may we expect to happen? Mustard plants will grow up. Who has ever seen *mustard* and *cress?* Mustard is grown from such seeds as these.

2. For what purpose do we grow mustard with cress? To eat. What part of the plant is eaten? All except the root.

3. Show young plants growing and seeds germinating. Notice the following:—

(*a*) Mustard plants grow easily and quickly in water.
(*b*) The first shoot bears two leaves as soon as it comes from the seed.
(*c*) The roots descend as far into the water as the shoot grows above.

4. Explain that if these plants were allowed to grow in the ground, they would in a few months become tall and tough, and unsuitable for eating. They would then bear flowers.

FLOWERS AND FRUIT.

1. Show specimens of flowers. The weed with yellow flowers often found on ploughed land has exactly similar flowers, and might serve for illustration. Notice the *cross* formed by the petals.

(*a*) The flowers are yellow.
(*b*) The petals form a cross (cruciform).
(*c*) The fruit consists of long pods holding the seeds.

FURTHER USES.

Medicinal—plasters, and as an emetic for vegetable poisons. Plasters draw blood from the seat of inflammation to the surface of the skin.

XI.

THE TURNIP.

A garden turnip, a swede turnip, with leaves; flowers and seed pods (or as in last lesson); turnip seed; young turnip plants growing from seeds.

A TURNIP EXAMINED.

1. Show specimens of turnip, and lead the children to notice the parts :—

(*a*) The leaves large, thick-veined, and rough.
(*b*) The globular part (or turnip).
(*c*) The thin root.

2. Examine more closely the *root* and the globular part :—

(*a*) Both are covered with hairy-like appendages.
(*b*) These are the rootlets.

It is through the rootlets that the water is taken out of the soil.

3. Cut through the globular portion from the top and through the thin root. Observe the characteristics of this portion :—

(*a*) It is firm, solid, and *yellow* (or white).
(*b*) It contains nothing but this *yellow* substance.
(*c*) The thin root is like it in appearance.

4. Show some specimens of young turnip plants. Notice the root is thin, without a globular part. Show partly grown turnips, and notice the gradual passage from a long thin root to the large round turnip. Hence the children should conclude—*a turnip is a thickened portion of the root.*

USES.

1. As a table vegetable. This is more on account of its pungent taste than for its value as a food. It contains only a moderate amount of nourishment, much of it being water.

2. As a food for cows it is excellent for increasing the yield of milk, but unfortunately it imparts its taste to the milk and butter.

TURNIPS IN THE SECOND YEAR; THE PURPOSE OF THE LARGE ROOT.

1. When the root has grown as large as it will, about the end of the year, it is generally pulled out of the ground to furnish food for man or beast. But let us try to find out for what purpose the root grows large.

2. If a turnip were allowed to stay in the ground all the winter through until the next spring, we should notice a stem growing up amongst the leaves. Soon flowers would appear, and after them the fruit or seed pods.

3. Show specimens of turnip flowers and fruit. Lead children to notice :—

(*a*) The flowers are yellow.
(*b*) They are cruciform, like those of the mustard.
(*c*) The pods are about two inches long, and contain round black seeds.

4. If we now pull up the plant, we shall find that all the thickened part of the root has disappeared. The root that remains is *long, tapering* and *tough*, and could not be eaten.

5. As a plant grows, what is it that takes up its food? The root. Now as the stem and flowers of our turnip were formed, they must have taken food; where did they get it from? The ground. But as they grew, what became of the thickened root? It wasted away. And where do you think it went as it wasted away? Into the plant to make *stem* and *flowers*. What then was the large root for? To supply the plant in the second year. Yes, it was food stored up; the large root is *a storage of food for the second year*.

6. Notice the duration of the plant. It dies after bearing fruit. How long does it live? *Two years*. On this account it is called a *biennial*. (Explain the term.) Mustard lives one year, and is called an *annual*.

GROWTH OF TURNIPS.

1. Show specimens of germinating seeds, notice the two small leaves as in the mustard.

2. Turnips are usually sown in spring. As they are often attacked by a beetle, they are sown thick and thinned out afterwards. A machine is used for sowing.

2. An ounce of seed contains as many as 14,000 seeds, and a single turnip has been known to weigh as much as 20 or even 30 lbs.

3. It has been calculated that a growing turnip seed may increase 15 times its own weight every minute.

4. The climate of England is well suited to the growth of turnips—especially in the county of Norfolk.

XII.

THE CABBAGE.

Well-grown examples of white cabbage, red cabbage, Savoy, cauliflower, winter greens, Brussel sprouts; flowers and seed pods; young plants.

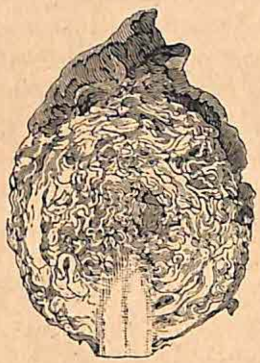

Fig. 17. A cabbage cut through the centre.

A CABBAGE EXAMINED.

1. Take an ordinary white cabbage in heart, with stem and root. Lead the children to give the names of parts, and to observe their characteristics.

(*a*) Broad thick leaves with large veins.
(*b*) The heart like a ball.
(*c*) Thick tough rough stem.
(*d*) A tapering root.

2. Break off the larger leaves and expose the heart. Strip off the leaves one by one until nothing but the stem is left, showing :—

(*a*) The heart consists of a number of leaves overlapping one another as in a *bud*.
(*b*) The leaves of the heart are *white*.

3. Question as to the cause of whiteness. Children may have seen a plant that has been grown in the dark. Plants only have green leaves when grown in the light. Why then are the cabbage leaves white? The outer leaves of the heart prevent the entrance of light.

4. Lead the children further to notice :—

(*a*) The stem within the heart is white and soft, ending in a point.
(*b*) The last and smallest leaves are at the point.
(*c*) Hence this is where growing is going on, and the smallest leaves are the youngest.
(*d*) As the plant grows these leaves enlarge, and so the plant is growing in the middle of the heart.
(*e*) The upward growth of the stem is checked by the tightly-packed leaves.

TWO-YEAR-OLD CABBAGES.

1. So far we have been observing a cabbage as it is cut in the summer or autumn to be eaten, and we have found it a large *bud*. But let us see what happens if the cabbage is not cut for food, but allowed to continue growing.

2. Lead children to think why some cabbages should be allowed to grow for a longer time. What must we do to get new plants? Show some young plants.

(*a*) Young plants are grown from seeds.
(*b*) Seeds are obtained from fruit.
(*c*) Fruit follows flowers.
(*d*) Hence cabbages must bear flowers and fruit before we can have seeds.

3. If left to grow through the winter, the heart leaves of the cabbage will gradually open out. Then the end of the stem appears and grows up to a height of two, three, or sometimes four feet. Flowers appear.

4. Show some cabbage flowers. If these cannot be had, any yellow crucifers will do for illustration. Lead the children to observe:—

(*a*) The flowers are yellow.
(*b*) They are cruciform, like those of the *mustard* and *turnip*.

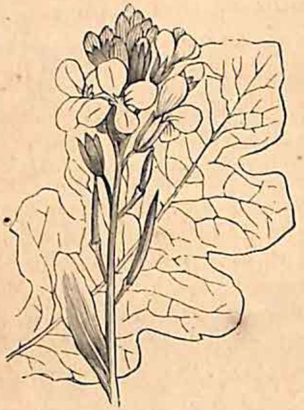

Fig. 18. Cruciform flowers of cabbage, with leaves and fruit.

FRUIT.

1. Describe by drawing, or show seed pods (fruit). They are like those of the turnip, but longer, from three to four inches, more pointed than those of the wallflower, which is another *crucifer*.

2. Show seeds. They are small, round, and bluish-black. They are usually sown in summer or autumn.

3. After the cabbage has borne fruit its work is done—it dies; hence it is a *biennial*.

OTHER MEMBERS OF THE CABBAGE TRIBE.

Show specimens, and give such information as the following:—

1. *Red cabbage* differs in colour; boiling takes out its colour.

2. *The Savoy* has wrinkled leaves.

3. *Brussel sprouts* are buds or small hearts that grow all the way up the stem. (Examine one.)

4. *The cauliflower* is the flower stalks and flower buds of a kind of cabbage. If left to grow, flowers exactly like the ordinary cabbage flowers would appear.

5. *The giant cabbage* is grown in Jersey to provide food for cows. Its stems, often 12 feet high, are sometimes used as walking sticks. Sixty plants will provide one cow with food for four years.

6. All these plants have been caused to grow as they do by *cultivation.*

An ordinary cabbage weighs but a few pounds, but some have been grown twenty-five pounds, and it is said one once reached the weight of *sixty pounds !*

The cabbage is the most ancient of the cultivated vegetables.

USES.

1. For food, generally boiled, or pickled with vinegar and spices.

2. For feeding cattle.

3. The Germans make from cabbage a drink which they call *sauerkraut.* It is a remedy and preventive for scurvy.

4. Cabbage is a wholesome vegetable. It acts as a purifier of the blood.

SUMMARY.

1. The flowers of *mustard, turnips* and *cabbages* are all *cruciform.*

2. The *fruit* of all three is in the form of long pods having a partition down the middle, on each side of which are small round seeds.

3. On account of these (and some other) resemblances they are said to belong to the same family.

4. The parts eaten are :—

(*a*) Of the turnip—the root.
(*b*) Of the mustard—the seeds and the young plants.
(*c*) Of the cabbage—the leaves.
Of the cauliflower—the flower stalks and buds.

XIII.

CULTIVATION.

Young turnip plants, water, salt, saltpetre, lime water.

WHAT IS CULTIVATION?

This question cannot be answered in a word. Let us consider it with regard to a turnip and see what cultivation has done, and by what means it has accomplished its end.

PLOUGHING.

1. Before a farmer sows his seed, what does he generally do to his land?

He ploughs it.

2. Now suppose he did not plough the land, but sowed his seed on the top of the ground, what would be likely to happen?

It would not grow. The birds would take it.

3. But have you never seen seeds growing that have fallen on the ground by the roadside?

Yes, very often, dandelions and others.

4. Exactly, and turnips would also grow, although some might be taken by the birds. But the ground would be hard and the roots would have to force their way into it. Into which would they grow the easier, ploughed or unploughed land?

Ploughed land.

5. Besides this, what kind of root does the farmer wish the turnip root to become?

A large thick root.

6. Yes. In which case would it grow the easier?

In the ploughed land.

7. Then why is the land ploughed?

So that the roots may push their way through the soil more easily, and be able to grow large.

8. That is so; and the farmer not only ploughs, but he uses other implements to break up the soil until he has made it quite loose.

STONING.

1. When land is ploughed or dug, what is generally found amongst the soil?

Stones are found.

2. If a turnip root were growing downward and met with a large stone, what would happen?

The root would be stopped or would have to turn round the stone.

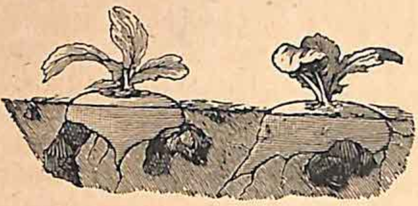

Fig. 19. Turnips in stony ground.

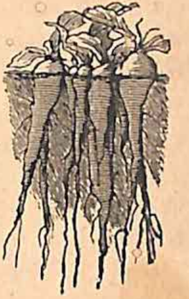

Fig. 20. Overcrowding.

3. Suppose there were other stones?

The root would have to go between them.

4. Yes; but what is the root seeking for in growing downwards?

Water; food.

5. What food would it find amongst stones?

None, or very little.

6. Then what must be done that the turnip may find plenty of food to take up by its roots?

The stones must be taken out of the ground.

SPACING.

1. We see then that the soil must be loose and free from stones. Suppose then our turnip seeds are sown. Generally they are sown very close together. Suppose they are allowed to grow in this way, how will they go on?

There will not be much room for each plant.

2. What difference will that make?

One will be in another's way, and they will not be able to grow large.

3. Yes, but there is something else. What does each plant require from the ground?

Food.

4. Now, if all the plants are crowded together, what will they do for food?

There will be very little for each.

5. So what kind of plants will they become?

Small plants.

6. Then if large plants with large roots are wanted, how must they be placed?

They must be planted far enough apart to give each one room to grow.

7. Yes, and so as to give each ground enough to get food from. The farmer generally sows his seed close because the young plants are very often attacked by a kind of *beetle* called the turnip *fly*, and many plants are eaten. But if those left are too close, he takes some out until the plants are about nine inches or more apart. The plants pulled out have to be thrown away, because they would not produce large roots if transplanted.

8. Look at these young plants (show some). The roots would always remain like these if the ground were stony or the plants were too close together.

WEEDING.

1. But after we have ploughed and sown, often something else grows up amongst the crops; what is it?

Weeds.

2. And if weeds are allowed to grow amongst the turnips, what difference will they make to the turnips?

They will rob the turnips of food.

3. If the turnips are robbed, what kind of plants will they become?

They will not grow so large as they would.

4. Then what must the farmer do?

Clear out all the weeds.

SUMMARY.

1. Let us now see what we have found out:—

(*a*) The land must be ploughed and well broken up.
(*b*) The stones must be taken out of it.
(*c*) The plants must not be close together.
(*d*) All weeds must be cleared out.

2. Doing these things is called *cultivation*. But this is only one part of cultivation. This might be summed up in a phrase as "cleaning the ground."

FEEDING.

1. Let us consider what a plant likes from the ground. Generally water.

2. We will put a little salt in this water, a little saltpetre in this. What has become of them? They have dissolved. Here is some lime water. Lime is dissolved in it.

3. Now these substances are all found in the earth as well as many others. The rain that falls to the earth sinks into the soil; it will meet with such things as these, and what then would you expect it would do to them? Dissolve them. And if they are dissolved in the water, and the water is taken up by the roots of plants, these substances also go into the plant.

4. Thus a plant gets, as it needs, much more than water.

5. In time, however, by growing many crops, these substances are all, or nearly all, taken out of the ground; how then will the plants get what they require?

They cannot get it. They will not grow well.

6. Just so, but surely we can help them in some way?

By putting something into the ground.

7. Yes, the farmer puts something on the ground. What is it?

Manure.

8. That is right. Manures of various kinds are put into the ground to supply plants with what they need to feed upon. So we have another way in which growth is aided. This is another part of *cultivation*.

SELECTION—HISTORY.

1. Just think a moment, suppose no manure were given to the soil, suppose there were no ploughing or digging, no stoning, no weeding, but that the seeds were allowed to fall and grow as best they could, what kind of turnips we should have. There would be no large roots. They would all be small and thin like an ordinary root.

2. Now this is just how turnips used to grow in the wild state

before they were cultivated. The root was as it now is in the second year, or perhaps just a little larger. Then there were no turnips as we know them.

3. Probably some one discovered that turnips such as they were formed wholesome food and were pleasant to the taste. The largest roots would be sought for. Some man, more thoughtful than his neighbours, would try to grow some by gathering seed and sowing it near his house. He would find that the better he looked after his ground the finer would the roots grow. Others would follow his example. Then one would try to grow larger roots than the others. He would carefully select the seed of those plants which produced the largest roots, and sow no seed but that. Then he would have plants with still larger roots; and so, by preparing his ground and every year choosing only the best seed for growing, he would in time grow turnips with much larger roots. Other men would give him things in exchange for his seed. And so, many would be able to grow larger turnips, and by acting on the same plan still increase the size of the roots.

SUMMARY.

Thus we see what is meant by cultivation. In the case of the turnip we may sum it up thus :—

(*a*) Ploughing and breaking up the soil.
(*b*) Clearing of stones.
(*c*) Spacing the plants.
(*d*) Weeding.
(*e*) Supplying food for the plants.
(*f*) Selection of best seeds for future sowing.
(And we might add)
(*g*) Sowing at the most suitable time.

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XIV.

THE CARROT.

Carrots with leaves, the same in flower (or flowers of some umbelliferous plant, such as parsley, fool's-parsley, hemlock or hog weed); carrot seeds; a parsnip.

PARTS OF THE PLANT.

1. Show specimens (if possible give one to every two children) and lead children to tell the parts :—

   (*a*) The leaves.
   (*b*) The long tapering root.

2. Examine the leaves more closely :—

   (*a*) The leaves are finely divided into many parts like a fern leaf.
   (*b*) They grow from the top of the root (the crown).

STRUCTURE OF THE ROOT.

1. Cut a cross section, and note what is seen :—

   (*a*) A thick outer coating of a deep pink colour.
   (*b*) A central core of a pale yellow.
   (*c*) A very thin outer skin.

2. Cut one of these pieces through the middle, from top to bottom, and again note :—

   (*a*) The central core, which may be compared to the wood of a tree.
   (*b*) The outer part, which resembles a thick bark.

3. Separate the bark from the core. Notice :—

   (*a*) The bark is easily broken (brittle).
   (*b*) The core is more tough and fibrous or woody.
   (*c*) This core shows projecting knots or points.

4. Take another piece and trace one of these projections through the bark to the rootlets. Explain what they are :—

   (*a*) These projections pass through the bark to small hair-like roots (rootlets).

- (*b*) The moisture is taken up by these rootlets and conducted straight to the centre or core of the root.
- (*c*) The leaves are attached to the core.

THE CARROT AS A FOOD.

1. Let the children taste both parts of the root separately:—
    - (*a*) The bark is the sweeter and more juicy.
    - (*b*) The core is harder, because more fibrous.

2. Explain that the sweetness is due to sugar contained. Evidently there is more in the bark than in the core. The best carrots for food are those with the smallest core and thickest bark.

3. Carrots are used as a table vegetable. Their chief value as food is in the sugar they contain—more than turnips and six times as much as potatoes. They are good food for cows.

OTHER USES.

No one has succeeded in extracting sugar from carrots. Only a syrup has been obtained, which does not crystallise. But a spirit called alcohol can be distilled from them. Alcohol is that which is contained in beer, wines, and spirits, and causes intoxication. It does not exist in the carrot as the oil of orange does in the rind of the orange. It is produced by fermentation from the sugar contained in the carrot.

FLOWERS AND FRUIT.

1. Explain how the carrot like the turnip forms its root during one summer, but when left in the ground forms a stem in the following year, the root diminishing in thickness and becoming more woody. In fact the thick outer covering becomes thin, being used up to make the stem and flowers which appear at the top of it.

2. For what purpose then did the carrot form a large root in the first year? Evidently as a store of food for future use: and this food was stored in the outer part of the root.

3. Show specimens of the flower. If not obtainable, any

umbellate flowers will do for illustration. Compare with an umbrella, hence the term *umbel.*

(*a*) The flowers are small and white.

(*b*) They grow in large flat clusters upon stalks starting from one point like the ribs of an umbrella. Such a cluster is called an *umbel.*

A POISONOUS FAMILY.

1. All plants with flowers like those of the carrot belong to the same family. Such are the *parsnip, parsley* and *celery.*

2. But many plants of the family are poisonous, *e.g.*, hemlock, fools'-parsley, and celery (when not bleached).

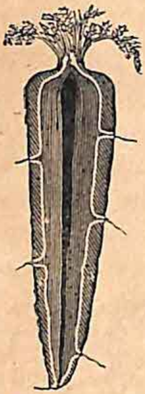

Fig. 21. Vertical section of carrot.

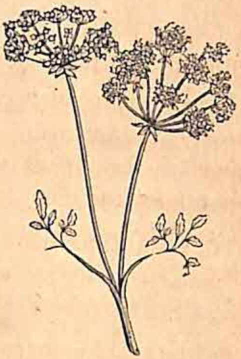

Fig. 22. Flowers of an umbellate plant, like the carrot.

XV.

THE POTATO.

Potatoes, (some sprouting), a plant taken carefully out of the ground with unripe potatoes attached; flowers and fruit; the same of the woody nightshade; a tomato.

HISTORY.

Give each child a potato (if sprouting so much the better); question on the use of potatoes and proceed to give a brief history.

It is only three hundred years since potatoes were first brought from America to England. Sir Walter Raleigh is generally credited with having first introduced them. People did not like them, for they had not found out the best way either to grow them or to use them. Sometimes they were eaten raw or just warmed. Now, next to bread, they are the most important article of diet we have. In many parts of Ireland they form the chief food of the people.

A POTATO EXAMINED.

1. Direct attention to specimens, and lead children to observe :—

   (*a*) Potatoes vary in shape and size, some being round, others long or kidney-shaped.
   (*b*) They are generally covered with soil, showing they have been in the ground.
   (*c*) Each has a number of "eyes."
   (*d*) In each eye is a *sprout* or *bud*.

2. Tell, how by keeping in a warm place or by putting them into the ground, these buds can be made to grow.

3. Cut open the specimens and observe :—

   (*a*) There is a thin outer skin.
   (*b*) The part within is compact and succulent.
   (*c*) There are no seeds.
   (*d*) Hence, it is not a *fruit*.

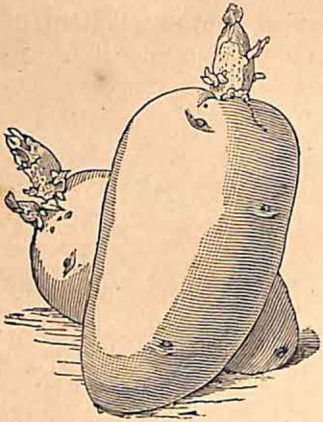

Fig. 23. Potato tubers, showing "eyes" and growing stems.

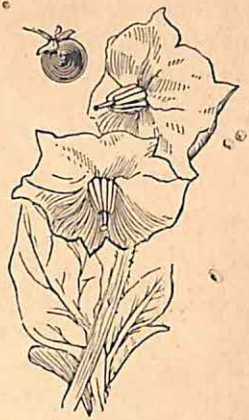

Fig. 24. Flowers and fruit of potato.

A GROWING PLANT.

1. Now let us imagine a potato to have been planted in the ground. The buds would soon begin to grow and lengthen into stems which would appear above the ground. At the same time roots would grow downwards into the earth. Next leaves grow on the stems, and in time flowers are often seen. Then follows the fruit.

2. Show specimens of flowers and fruit, or give a description. Lead the children to notice :—

(*a*) The colour of the flowers, white or purple.
(*b*) The round berry, of about the size of a marble.

3. By cutting it open show that the fruit is a *berry*. It will become black when ripe. From the seeds which it contains new plants can be grown.

4. Show the flowers of the Woody Nightshade or Bitter Sweet. Point out their resemblance to potato flowers. Both belong to the same family. The nightshade berries are *poisonous;* so are the berries of the *potato*. *Tobacco* is another poisonous plant of this family.

5. Show a *tomato*. This is a berry of another plant of the same family, but it is not poisonous, on the contrary it is very wholesome. It used to be called the *Love apple.*

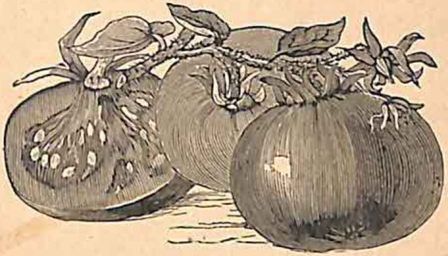

Fig. 25. Tomatoes (love apples), one in section showing seeds; leaves, and flowers.

WHAT ARE POTATOES?

1. Now we have seen that potatoes are not borne upon the stem of the plant. Most children will know that they are dug from the ground.

2. Show a plant bearing potatoes. Notice:—

(*a*) The thick weak stems and leaves.
(*b*) The potatoes on what appear to be roots.

3. Point out that the potatoes are attached to something different from the thin fibrous roots.

4. Show by drawing the position of the potatoes and the direction of the parts on which they grow (horizontal).

5. Recall the underground stem of the raspberry and the purpose it served.

6. The potato has likewise an underground stem. Notice the potato grows at the end of it. It is a thickened part of it. Just as the raspberry underground stem sent out buds to grow up above the ground, so this plant forms buds in the thickened part of its underground stem to grow up at some future time.

7. Such thickened portions or ends of underground stems are called *tubers*.

A potato is a tuber.

WHAT A POTATO CONTAINS.

1. Take a peeled potato, grate it and wash out the fibre and there will be left a white insoluble powder. This is *starch*.

2. Notice the wetness of a potato when cut. It contains much water. About three-quarters of it is *water*.

3. It also contains a little sugar, from which a spirit (alcohol) is distilled.

4. Much starch is obtained from potatoes.

5. A potato then contains :—

   (*a*) Water.
   (*b*) Starch.
   (*c*) Sugar.
   (*d*) A little woody fibre.

SUMMARY.

1. Potatoes are tubers.
2. Tubers are thickened ends of underground stems.
3. They grow for the purpose of giving new plants when the old ones are dead, thus acting like seeds.
4. Although the berry is poisonous, the tuber is quite wholesome.
5. It contains chiefly water and starch.

XVI.

THE ONION.

A few dried onions; some green, with leaves; one in flower; seeds.

THE ODOUR AND FLAVOUR OF ONIONS.

1. Show dried specimens; question on the use of onions and their characteristics :—

   (*a*) Onions are chiefly used as food in the form of seasoning with other foods.
   (*b*) Their most striking characteristic is an exceedingly *pungent* odour.

2. Allow some children to eat pieces of onion, holding the

nose whilst doing so. Nothing of the strong taste will be perceived. In fact, it is not the *taste* of the onion that is strong, but the *odour*. This perceived whilst eating is called a *flavour*. So the onion has a strong flavour.

STRUCTURE OF AN ONION.

1. Cut an onion vertically through the centre and show :—
   - (*a*) It consists of overlapping layers.
   - (*b*) These layers are thick and white.

2. Show a specimen of a growing onion, noting carefully its parts :—
   - (*a*) The root.
   - (*b*) The thick, white globular part.
   - (*c*) The leaves.

3. Explain that the globular part is called a *bulb*. Notice that the leaves are round and hollow, like a pointed tube.

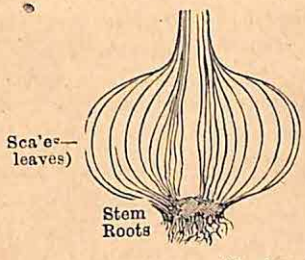

Fig. 26. Bulb of onion, with stem and roots.

THE BULB—WHAT IT IS.

1. Carefully strip off the leaves of a green onion one by one, without allowing them to break off at the top or side of the bulb. Thus show that each leaf is continued in a layer of the bulb.

2. Separate the layers of the specimen first cut, and expose the stem or *growing point* in the centre.

3. Recall the structure of the heart of a cabbage and compare :—
   - (*a*) The layers of the bulb are leaves.
   - (*b*) The growing point of the stem is in the centre.
   - (*c*) Therefore the bulb resembles a *bud*.
   - (*d*) The bulb is not the root.

4. Get from the children the definition of a bulb. A bulb is a number of thickened leaves overlapping one another so as to form a hard globular body.

THE PURPOSE OF THE BULB.

1. Some bulbs if planted give off other bulbs at the base. These bulbs can be saved and planted to produce fresh onions.

2. These bulbs then are *buds* from which new plants can be grown.

3. But why are the leaves thickened? For this purpose: the onion is a biennial, and in the second year up grows a stem bearing flowers and afterwards fruit; as it does so the bulb wastes away. What becomes of its thickened leaves? They are reduced in giving food to the *stem*, *flowers*, and *seeds*. For what purpose then were they thickened? To provide food for the growing stem.

Then each thickened leaf contains a store of food for future use.

FLOWERS AND FRUIT.

1. Show specimens or sketch on the black board. Notice:—
   - (*a*) The stem is hollow and broader in the middle.
   - (*b*) The flowers grow in a globular head on little stalks.
   - (*c*) They are greenish white.
   - (*d*) Seed pods follow the flowers.
   - (*e*) The seeds are small, round, and black.

FOOD.

As a food the onion is very wholesome. It has also medicinal properties.

RELATIVES.

Of the same family as the onion are:—

- (*a*) Leeks.
- (*b*) Garlic.
- (*c*) Chives.
- (*d*) Lilies.

A BRIEF SUMMARY.

FOOD YIELDED.

1. All the plants we have studied furnish us with food in some form or other. Such products are generally spoken of as *fruits* or *vegetables*.

But all are *vegetable*, whether fruits or other parts of a plant.

2. All yield *fruits*, but it is only the fruits of some that are used as food; of others we use leaves, stems, flowers or roots.

The following summarizes the food-forming products :—

Fruits—Apple, pear, plum, cherry, peach.
Grapes, gooseberries, currants, orange, lemon, tomato.
Raspberry, blackberry, strawberry.
Kidney bean.

Seeds— Mustard, almond, peas and beans.

Leaves—Cabbage, mustard (when young).

Flower stalks—Cauliflower.

Roots— Turnip, carrot, parsnip.

Tubers—Potato.

Bulb— Onion.

OTHER PRODUCTS OF THE SAME PLANTS.

Apples	yield	cider.	Mustard seeds	yield	mustard oil.
Grapes	,,	wine.	Parsnips	,,	wine.
Blackberries	,,	wine.	Carrots	,,	alcohol.
Oranges	,,	wine and oil of orange.	Potatoes	,,	alcohol and starch.
Lemons	,,	oil of lemon.			
Almonds	,,	oil of almonds.			

XVII.

GRASS.

"The herb yielding Seed."

A sufficient quantity of tall and short grass to provide each child with a specimen; flowers of grass; hay; "hay seeds"; sword blade grass.

DISTRIBUTION AND USES.

1. Introduce the lesson by some questions and observations on the more obvious aspects of the subject:—

(*a*) Grass grows by the roadside, in fields, on hills, and the lower slopes of mountains; in crevices between stones, in water, on the roofs of houses—almost everywhere.

(*b*) It supplies food for horses, cows, sheep, goats, and many other animals.

(*c*) Its green colour is very pleasant to the eyes.

(*d*) It forms a natural carpet for the ground.

2. Lead the children to try to imagine the earth without grass—call to mind some place destitute of grass.

3. When does grass grow most quickly? When most slowly? What do cattle eat when the grass is not growing? Show specimen of hay and ask how it has been made:

(*a*) Grass grows most quickly in spring and summer, least of all in winter.

(*b*) Hay is dried grass; the grass is cut down in summer, dried and stacked for winter use.

(*c*) Grass is also preserved without drying.

A BLADE OF GRASS.

1. Give to each child a specimen of grass, each specimen having *roots*, *stem*, and *leaves*. If the stems are short, give out also some long stems bearing blades.

2. Hold a specimen in the left hand, requiring the children to do the same. Draw one of the leaves between the finger and thumb from the bottom upwards, and lead the children to tell:—

(*a*) The leaf is long, narrow, and pointed.
(*b*) It bears some likeness to the blade of a knife.
(*c*) Hence it is called a blade of grass.
(*d*) A *blade* of grass is a *leaf*.

3. Now require each child to take a blade in the right hand and carefully pull it downwards, so as to pull it from the stem. Observe the folding; compare with a sheath; notice the point of attachment. The children should tell:—

(*a*) The lower part of the leaf is folded round the stem.
(*b*) This folded part is like a *sheath*.
(*c*) Younger leaves are often enclosed in the sheath.
(*d*) The sheath ends at a *knot* in the stem; there it breaks off.
(*e*) The stem has several knots.
(*f*) The stem is hollow except at the knots.

ROOTS OF GRASS.

Examine carefully the roots. Contrast with carrot and turnip:—

(*a*) The roots are in small threads or fibres.
(*b*) There can nowhere be found a tapering root as in the carrot.

FLOWERS AND FRUIT.

1. Show specimens of grass in flower. Draw attention to the numerous small flowers and the absence of colours. Question of what follows flowers—fruit. What does the fruit always contain? Seeds. Have they ever seen seeds of grass? Hay seeds. Show some. Suppose these were sown:—

(*a*) The flowers of grass are very small and very numerous.
(*b*) They have little colour different from the plant on which they grow.
(*c*) Fruit follows the flowers—in the fruit are seeds.
(*d*) Hay seeds are the seeds of grass.

2. Show specimens of various grasses, quaking grass, rye grass, meadow grass, etc. These and others are often gathered and kept in vases on account of their great beauty.

SOME OTHER FEATURES.

1. Show some sword blade grass. A blade drawn between the

fingers readily cuts the skin. Why? Explain that there is a coating of *flint*—especially strong on the edge of the blade. Refer to the hardness of flint. The flint has been taken from the earth.

2. Consider how easily a tender blade of grass seems to push its way through the hard ground. This is due to the flinty coating which is present in a greater or less degree on all grass.

3. Notice the fact that the more grass is cropped, the more close does it grow, hence an additional suitability as food for cattle. The more it is cut, the more do the stems branch out and form new roots; and the more the roots grow, the more the leaves and stems grow.

4. Explain how *turf* is thus formed. The matted mass of roots serves to bind the soil together, and often loose soil is kept from being washed away, and the hard rocks from being laid bare, as they would be if there were no grass.

CHARACTERISTICS—SUMMARY.

Grass is known by:—

(*a*) Hollow knotted stems.
(*b*) Blade-like leaves sheathing the stem and fastened at the knots.
(*c*) Fibrous roots.

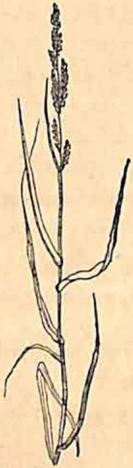

Fig. 27. Grass, leaves, and flowers.

XVIII.

WHEAT.

Grains of wheat; flour, bran; ears of wheat, wheat straws, growing wheat stems; some soaked grains of wheat, some germinating. (These should be sown in a moist warm soil, or on wool over water 10 or 12 days previously.)

BREAD.

Refer to most important article of diet—our daily bread—the Staff of Life. Why so called. By questions :—

(*a*) Bread is made from flour.
(*b*) Flour is obtained by grinding wheat.
(*c*) Wheat is grown in fields.

A GRAIN OF WHEAT.

1. Give to each child at least one dry and one soaked grain of wheat. These are called *grains*. Compare with *grains* of sand.

2. Get a careful examination of the grain carried out so as to observe the following characters :—

(*a*) The grain is brownish-white in colour.
(*b*) It has a furrow down one side.
(*c*) On the opposite side at one end is a scar.

3. Take the soaked grains, and with a fine point, such as that of a pin, needle, pen or knife, remove the scar and take out a small pointed lump which easily comes away.

4. Now show germinating grains. Tell the children that they have been sown and kept moist and warm. Notice carefully the following :—

(*a*) A root and stem growing from the grain.
(*b*) This is a young plant, and it grows from the place indicated by the scar.
(*c*) Therefore the little lump removed was a young plant that had not begun to grow.
(*d*) Warmth and moisture cause it to grow.
(*e*) Hence the grain is a seed.

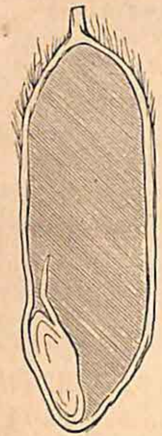

Fig. 28. Grain of wheat in section, showing plantlet or embryo.

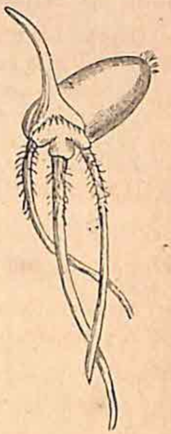

Fig. 29. Grain of wheat germinating.

5. Look again at the grains. Cut them across. Observe:—

(*a*) The grains have a tough coat.
(*b*) They are filled with a white powder.

6. This powder is what we call *flour* when the grain is ground. But what part of the seed is it? Just consider what the little plant lives upon before it has grown roots to take up moisture. This white powder is its food. Therefore the grain consists of:—

(*a*) A brown tough outer coat.
(*b*) A little plant.
(*c*) A store of food for the little plant.

THE WHEAT PLANT.

1. Suppose these germinating grains in the ground; describe their growth. They are generally sown before winter begins. If you have some growing specimens call attention to the resemblance to grass.

The plant continues to grow until it has a tall stem bearing leaves, and an ear at the top. At first several stems branch out at the base, and the more room the plant has the more will it branch; every branch stem ends in an ear.

2. Show specimen of a grown plant. Observe:—

(*a*) The root is fibrous.
(*b*) The stem is knotted and hollow.
(*c*) The leaves are blade-like, and in the lower part form a sheath round the stem.
(*d*) Therefore *wheat is a kind of grass.*

THE FULL CORN IN THE EAR.

1. Give children ears of wheat to handle. Let each take off as much as contains a grain. Examine this:—

(*a*) Some chaffy scales.
(*b*) A grain of wheat.

2. Explain that before this grain grew there, its place was occupied by a flower—a green flower. Make a sketch of one on the black board. If then the grain has replaced the flower, what is it? *The fruit.* A grain of wheat is the fruit; it contains a seed, just as a plum is a fruit and contains a seed, though there is no hard stone or soft pulp in this case.

USES.

1. All parts of the wheat plant are useful, but it is chiefly the fruit or grain to which we are indebted; when ground it produces:—

(*a*) Meal, from which are taken—
(*b*) Bran, the outer coat, and
(*c*) Flour, the white portion.

2. Many children have chewed wheat until it becomes like india-rubber. That part of the wheat is called *gluten*, and it is that which makes wheat such nourishing food. *Gluten* contains that which will make muscle.

3. The plant also furnishes us with:—

(*a*) Straw—the stems.
(*b*) Chaff—surrounding the grain.

4. Malt is made from the grain, and *alcohol* is distilled from it.

DISTRIBUTION.

Wheat grows well in England, but not in Ireland (except in the Golden Vale) for it is too wet, nor in Scotland, for it is too cold there. It likes sunshine, but does not grow well if the country is too hot. Large quantities of wheat come to us from America and Australia.

XIX.

SOME OTHER GRAINS.

Grains of oats, barley, rye, wheat, rice, millet; ears of the same; malt, oatmeal; straw of the same.

THE GRAINS COMPARED.

1. Give specimens of each kind of grain; notice that they are called grains; observe their characters and tell their names :—

- (*a*) *Wheat*, a short furrowed grain.
- (*b*) *Barley*, similar to wheat, but thicker, and without the furrow.
- (*c*) *Rye*, resembles barley, but is a smaller grain.
- (*d*) *Oats*, long and thin.
- (*e*) *Rice*, a small hard white grain. Before the outer coat was removed it was somewhat like barley, but flatter.
- (*f*) *Millet*, a small round shiny grain.

PRODUCTS.

1. All these grains are used as food. Question on their uses. Oats, rye, and millet are often given to cattle or poultry.

2. Grinding produces meal. (Illustrate the action of grinding.) The meal is cleansed by sifting.

3. Take each in turn, and question as to its products. Show specimens as far as possible.

- (*a*) *Wheat* yields flour, bran, malt.
- (*b*) *Barley* yields meal, pearl-barley, malt.
- (*c*) *Rye* yields meal, from which bread was, and in some places is still, made.
- (*d*) *Oats* yield meal for porridge and oatcakes.
- (*e*) *Rice* yields ground rice, starch.
- (*f*) *Millet* yields meal—used in Italy.

MALTING.

Question on what took place when wheat grains were kept warm and moist. They began to grow, a young plant appeared. In malting—this is caused to take place by putting the grain (wheat or barley) in a warm moist room. As soon as the little plant has begun to grow, the temperature is raised to 104°. The heat kills the little plant. But a change has taken place in the store of food in the grain. It is now in such a state that *alcohol* can be distilled from it.

THE GRAIN IN THE EAR.

1. Show ears of the different grains, and notice their characteristics :—

   (*a*) Wheat, close and compact.
   (*b*) Barley, with a long beard.
   (*c*) Rye, similar, but more slender.
   (*d*) Oats, a spreading, branched, and graceful ear.
   (*e*) Rice, a branched ear.
   (*f*) Millet, very heavy and compact. It is said to take its name from the Latin word mille, *a thousand*, on account of its numerous grains.

2. Recall the description of the wheat, and show that these ears are the *fruit* following the flowers, all which resemble wheat flowers.

ALL ARE GRASSES.

1. Take specimens of stems (straw) and lead the children to notice :—

   (*a*) Hollow knotted stems.
   (*b*) Blade-like sheathing leaves.
   (*c*) Fibrous roots.
   (*d*) General resemblance to grass when growing.

2. Therefore all these plants are grasses.

DISTRIBUTION.

Give the following information :—

(*a*) Wheat grows well in the south-east of England.
(*b*) Oats succeed wheat going northward.

(*c*) Barley and rye are more easily grown, and consequently have a wider range.
(*d*) Rice and millet are not grown in England. They require a hotter climate.

FROM THE FIELD TO THE OVEN.

1. Question from the children the processes through which grain must pass before it can be used as food :—

(*a*) Reaping, binding, drying.
(*b*) Carrying home and stacking.
(*c*) Threshing the grain from the ear.
(*d*) Winnowing the grain from the chaff.
(*e*) Grinding between stones or rollers.
(*f*) Sifting.
(*g*) Mixing with water, salt, and yeast.
(*h*) Baking.

2. As the common grasses yield abundant supplies of food for cattle, so these grasses give both food for cattle and furnish the chief food of mankind.

XX.

MAIZE.

Indian corn, yellow, pale, and red ; meal, cornflour, starch ; cobb or ear of maize ; picture of plant ; some soaked corn ; some germinating.

INDIAN CORN.

1. Distribute to the children dry and soaked grains. Most children will know the name, Indian corn. It is so called because when first found it was the corn cultivated by the Indians of North America. It is still brought from there in large quantities. Another name is *maize*.

2. Let the children examine the grains, and lead them to observe :—

(*a*) The grains are larger than any we have seen.
(*b*) They are broad, flat, and pointed on one side.
(*c*) A thin skin peels off when they are softened.
(*d*) The greater part of the grain is hard and yellow (or red).
(*e*) The other part is softer and white.

3 Recall the appearance of a grain of wheat, and what was beneath the scar. Show germinating grain. A young plant is growing out at this point. Then under the dried white part is similarly a little plant.

(*a*) The grain contains a young plant.
(*b*) The other portion is food for the little plant, exactly as in a grain of wheat.
(*c*) Hence this grain is also a seed.

USES.

1. Question on known uses, and supplement the children's knowledge :—

(*a*) The whole grain gives food to poultry and cattle.
(*b*) Ground into meal it is used for the same purpose.
(*c*) *Starch* and *cornflour* are manufactured from it.
(*d*) In America the corn is often boiled when green and eaten So plentiful is it there that it has been used as *fuel*.

2. Maize is not so nourishing a food as wheat. It contains less *gluten*.

THE CORN IN THE EAR.

1. Show an ear or cobb of maize. If one cannot be procured, make a drawing on the black board and give the following facts :—

(*a*) An ear is about 10 inches in length, and 6 to 8 in circumference.
(*b*) The weight varies from half a pound to a pound.

2. Proceed to notice details either from the specimen or from the drawing, aided by description :—

(*a*) The grains are very numerous—as many as 450 in one ear.
(*b*) They are tightly packed side by side.
(*c*) The close growth gives the flattened shape.
(*d*) The yellow hard horny side of the grain is the outer one.
(*e*) The inner soft pointed side is attached to a central pith. This pith is called the *cobb*.

3. When growing, the whole ear is encased in a membranous sheath, and from the top hangs a tassel of silky threads, each thread arising from the base of a grain. These threads are the remains of the flowers. What then is the ear? The fruit.

THE MAIZE PLANT.

1. If you have some grains sufficiently grown, the children can readily see that:—

(*a*) The plant grows up like very strong wheat or grass.
(*b*) It has blade-like leaves.

2. Explain that although the plants will grow in England and bear flowers and fruit, the grain does not ripen, the climate not being sufficiently hot.

3. Give a description, aided by a drawing, of the plant. It grows to a height of sometimes as much as twelve feet. The stems are thick and knotted and hollow. Notice the resemblance to grass. *Maize is a kind of grass.* Think of grass with such large ears of grain!

FLOWERS.

1. The central stem bears a large tuft of yellow flowers. Compare with palm gathered for Palm Sunday. This flower is however larger and more spreading.

2. The side branches bear flowers, which are followed by the ears of grain. *Yellow dust* must fall from the central flowers on these or no corn will be produced. The silky threads catch the yellow dust.

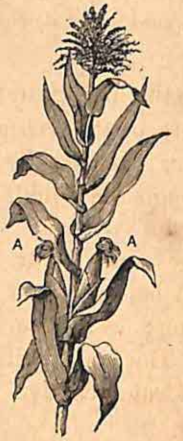

Fig. 80. Maize. A Flowers that produce the grain.

XXI.

THE SUGAR CANE.

Brown, white and loaf sugar; treacle and syrup, sugar candy; sugar cane; picture of the plant.

SUGAR AND ITS PROPERTIES.

1. Show, and question about, the different kinds of sugar. Ask for its uses; they may be included under two heads.

(*a*) For sweetening.
(*b*) For preserving.

Hence one of the properties of sugar—it is *sweet.*

2. Show specimens and lead children to observe:—

(*a*) It consists of small hard particles.
(*b*) These particles are bright and sharp-edged.

Explain that such particles are called *crystals.* Compare with crystals of salt or rock crystal.

3. Dissolve some sugar in hot water, some in cold, and melt some in an iron spoon, showing:—

(*a*) Sugar is dissolved in hot water *quickly.*
(*b*) Sugar is dissolved in cold water *slowly.*
(*c*) It is melted by heat.

4. In the solution notice the disappearance of the sugar. Let the children taste to be sure of its presence. Each crystal has been separated into smaller particles by the water, and these have spread about all through the liquid. In *melting,* the sugar is turned into a *liquid* called a *syrup.*

5. *Crystallization.* Show some sugar candy and notice the large crystals. Dissolve in boiling water as much sugar as the water is capable of taking; evaporate, having some strings suspended in the liquid. The sugar will be crystallized about the strings in the form of sugar-candy. The strings assist the particles to gather together.

6. Summarize:—
   - (*a*) Sugar consists of small crystals.
   - (*b*) These crystals can be dissolved in liquids.
   - (*c*) The crystals can be formed again from the liquid—nothing is lost.

THE PLANT FROM WHICH WE GET SUGAR.

1. Sugar may be obtained from various plants, but the one which yields it most profitably is the sugar-cane. This plant grows in hot countries, especially in the West Indies, where the climate is so hot that only black people can work in the sun.

2. Show a picture of the plant, and lead the children to notice:—
   - (*a*) It has grass-like leaves.
   - (*b*) The stems are round and knotted.
   - (*c*) There is a feathery tuft of flowers at the top similar to those of the maize.

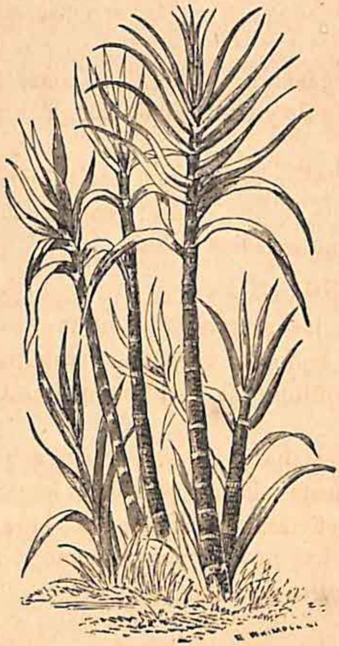

Fig. 31. Sugar Canes.

3. Compare with maize. Show that it is a grass. It grows to a height of twenty feet. The stems are like cane. Hence the name, sugar cane.

4. Although the plant might be raised from seed, this is not often done. It is generally grown from cuttings.

5. Children who live where these canes grow, are very fond of a piece of green sugar cane.

EXTRACTION OF THE SUGAR.

1. The canes are cut down, tied in bundles, and crushed between rollers to extract the juice.

2. Compare this juice with water containing dissolved sugar. What must be done to get the sugar from the juice? How can this be done?

(*a*) The water must be taken from the sugar.
(*b*) This can be done by heating.
(*c*) The water goes away as steam or vapour.
(*d*) This process is called *evaporation*.

3. The juice is generally boiled three times, and the impurities are skimmed off as they rise to the top. The refuse of the canes serves as fuel.

4. The syrup is then cooled and put into casks over cisterns. The sugar remains in the casks; that which will not solidify drains through, and is called *treacle*.

SUGAR REFINING, ETC.

1. When sugar is brought to us it is *brown* and has to be refined, that is to be made *white* and crystallized. This is done by still further boiling. It then often appears in the form of sugar loaves.

2. It is reckoned that 110 well-grown canes will produce 5 gallons of syrup, from which 6 pounds of sugar can be extracted.

3. Sugar in moderate quantities and *pure* is a good food. Once a luxury, it has now almost become a necessity. Before sugar was known, *honey* was used.

XXII.

THE BAMBOO.

Specimen of bamboo; any article made of bamboo, flint.

PROPERTIES OF BAMBOO.

1. Show specimen of bamboo, give its name and question on the uses to which it is put in England.

2. Split a piece to show its internal appearance. Lead the children to examine it and to tell:—

(*a*) Bamboo is a kind of wood.
(*b*) It must have grown as a plant.
(*c*) It has ring-like notches or knots.
(*d*) It is hollow.

3. What part of the plant do you think the bamboo is? The stem. Have you seen stems that were hollow? Yes, those of grass. What else has bamboo which stems of grass have? Knots. What grew at the knots of the grass stems? Leaves.

Summarize:—

(*a*) Bamboos are stems.
(*b*) Leaves have once grown where the knots are.

4. Strip off fibres and show how easily it can be broken longitudinally. Let boys try to break it across. Observe:—

(*a*) The bamboo stem consists of fibres very close together.
(*b*) These fibres can easily be pulled apart one at a time from the inside.
(*c*) The stem cannot be broken across It is very tough.
(*d*) It is also very light.

Such sticks are called *cane.*

5. Call attention to the outer coating. Apply a knife to scratch it. Scrape off a portion and lay bare the fibres. The children should tell:—

(*a*) The bamboo is covered with a shiny coating.
(*b*) This coating is very hard; a knife will not scratch it.

(c) It will serve as a protection to the fibres.
(d) It will hold the fibres together.
(e) Therefore this coating makes the bamboo much stronger.

6. Show a piece of flint; try to scratch it with a knife. Explain that this coating is flint which the plant has taken from the ground. By the aid of a piece of steel fire may be struck on it as on ordinary flint.

7. Show some wheat straw and notice the hard shiny exterior. This is also due to the presence of flint.

8. Bamboo is therefore:—

(a) Both hard and tough.
(b) Its toughness is due to its fibres.
(c) Its hardness is due to its flinty coating.

BAMBOO A GIANT GRASS.

1. Recall the characters of bamboo—hollow knotted stems, the leaves growing at the knots.

2. Sketch on black board and show the leaves, like large blades of grass. It resembles grass in:—

(a) Hollow stems.
(b) Knots in the stems.
(c) Coating of flint.
(d) Blade-like leaves

3. Bamboo is a giant grass. It grows in China and Japan—countries with a warmer climate than our own. The sugar cane at twenty feet we should think a very tall grass, but the bamboo sometimes grows to three times that height. It grows very rapidly—as much as a foot during a single night.

4. A clump of bamboo looks like a giant sheaf of corn standing upright.

USES OF THE BAMBOO.

The bamboo is a most useful plant to the Chinese and Japanese. It is therefore cultivated with great care.

1. Of the *whole stem* houses and bridges are built, chairs and tables are made, and pipes are formed for carrying water.

2. The *split canes* serve in the same operations, and for spouts or open gutters.

3. Of the *fibres*, ropes and sails of ships, mats and bedding, screens and baskets are made. From them, too, paper is manufactured, and the wicks of candles are obtained.

4. The young shoots form an article of food. It is said to be used "in a thousand ways."

THE GRASS FAMILY.

No family of plants renders such service to mankind as the grass family—its uses are endless and not the least is the beautiful carpet of green spread over what would otherwise be a bare and cheerless landscape. It provides us with the "Staff of Life."

XXIII.

THE COCOA-NUT.

A cocoa-nut, some cocoa-nut oil; a door mat or similar product; picture of palm; a nut with the fibrous covering (if possible).

THE "NUT."

1. Show a cocoa-nut. Observe :—

   (*a*) It is oval in shape.
   (*b*) It is from 4 to 6 inches in length.
   (*c*) There are three holes at one end.

2. Break open the nut with a hammer. Have a vessel to receive the "milk." Lead children to tell :—

   (*a*) The outer covering is hard and shell-like.
   (*b*) This contains a white kernel.
   (*c*) The kernel is hollow and contains a milky liquid.
   (*d*) The liquid is sweet.

3. This white kernel contains a small plant like the grain of wheat or maize. It is situated at the end near the holes. If the nut were put into the ground in a warm country, the little plant would grow through one of the holes, and in a few years become a tree. Hence conclude :—

(*a*) The nut is a seed.
(*b*) The holes are for the growth of the little plant.

THE COCOA-NUT PALM.

1. Lead the children in imagination to the land of the cocoa-nut palm. The tree only grows in tropical countries. It is generally found overhanging water.

2. Show a picture or make a sketch. It is a tall unbranched tree, about a hundred feet in height, having a great tuft of feather-like leaves at the top. A leaf measures about 12 feet in length. (These lengths should be shown.)

3. The stem is of nearly equal thickness throughout its length, and it does not increase when once it has reached a certain thickness. Such trees are called *palms*.

MORE ABOUT THE "NUT."

1. The nut when growing is not as we buy it from the shop. It is about 10 inches long and as big as a boy's head. The whole mass consists of the following :—

(*a*) An outer coat.
(*b*) A fibrous covering.
(*c*) The "nut" containing
(*d*) The kernel and "milk."

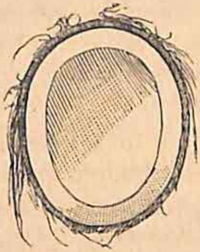

Fig. 32. A Cocoa-nut.

2. Show the above parts by drawing, or better from actual specimen. Fibres may be seen in mats.

3. Draw a comparison between the nut and a *plum*, by recalling first, the parts of a plum, then the parts of the cocoa-nut.

(*a*) The outer coat corresponds to the skin of the plum.
(*b*) The fibrous part corresponds to the pulp of the plum.
(*c*) The shell corresponds to the stone of the plum.
(*d*) The kernel corresponds to the kernel of the plum.

It differs from the plum in two respects :—

(*a*) It has fibres instead of pulp.
(*b*) The kernel contains a sweet watery juice.

4. Just as the plum is the *fruit* of the plum tree, this is the *fruit* of the cocoa-nut palm, and the nut or *stone* holds the seed. What name did we give to such a fruit as a plum? A drupe. This fruit is also a drupe, and the nut is really the *stone*. We eat the kernel.

USE.

Briefly describe the following uses :—

1. The kernel is eaten as food.

2. Of the fibres (called coir) ropes and mats are made.

3. In its own country the leaves of the tree furnish material for the roofs of houses, as well as a kind of paper for writing upon. A rough cloth is also made from them, and the *midribs* are used as oars.

4. The wood is used for building huts and forming gutters to carry water.

5. From the roots baskets are made.

6. From the kernel an oil can be pressed. Show specimen. It is called cocoa-nut oil, and it is used in soap and candle-making. Ten nuts will yield a quart of oil.

DISTRIBUTION.

1. As the tree grows by the waterside the fruit is often dropped into the water and carried sometimes thousands of miles before it is washed ashore. The seeds do not suffer from this soaking in salt water, but they will grow and produce trees on another shore after so long a voyage.

2. But what purpose does the "milk" serve? What do seeds require to make them begin to grow? Heat and moisture. In the dry sand there is little moisture. The store of milk is a bountiful provision in a thirsty land. Like the camel, the cocoa-nut is adapted to a life in the desert.

XXIV.

THE DATE.

Some dried dates, the same on stalk; picture of the palm.

A DATE.

1. Allow the children to examine specimens and lead them to tell :—

   (*a*) A date is oblong in shape.
   (*b*) Its skin is shrivelled and hard, smooth and shiny.

2. Cut open and observe :

   (*a*) The skin surrounds a soft pulp.
   (*b*) The pulp is sweet to the taste.
   (*c*) In the centre is a hard stone which easily separates from the pulp.

3. Examine the stone; break one :—

   (*a*) The stone is long, and pointed at each end.
   (*b*) It has a long furrow down one side.
   (*c*) It is not a kernel covered by a shell as in a plum stone.
   (*d*) The shell is but the outer covering of the softer inner part, and cannot be separated.
   (*e*) The stone is therefore the *seed.*

4. If these seeds were sown, date trees would grow up from them and bear fruit again—but not in England. They remain dwarf trees with us, and are used for decoration.

THE HOME OF THE DATE.

Egypt and North Africa are the home of the date. Much of these countries is desert, and a few dried dates are usually the only food a traveller takes with him in crossing the sandy wastes. Sometimes after miles of journey over scorching sand he sees in the distance a clump of trees. There he knows he will find water, and grass for his camel. The trees are date trees, and if they are in fruit he is fortunate indeed. These are wild dates, but dates are also cultivated, and often a man's whole wealth consists of his date trees.

THE DATE PALM.

1. In appearance the date tree resembles that of the cocoa-nut. Recall the features of this tree. What was it called? A palm. The date tree is also a palm, but not so tall as the cocoa-nut—not more than sixty feet.

2. What part of the tree are the dates? The fruit. Then they must have been preceded by flowers. Some trees produce one kind of flowers, others another kind—one kind fruit-producing, the others not. The latter bear a yellow dust only, such as we may see in any of our flowers. This yellow dust must be carried either by the wind or by hand, and put into the fruit-producing flowers, or else no fruit will follow the flowers.

3. Dates are gathered before they are ripe, and dried for exportation. Show dates on stalk, or a drawing of them.

USES.

1. In England, dates are scarcely used as a regular food, although they are both wholesome and nourishing; they are treated as a luxury.

2. In countries where they are grown, they form along with rice and coffee the regular food of the people.

3. The *seeds* are ground into meal for camels, or made into beads.

4. The *wood* of the stem is too fibrous to be of use in any way but as poles.

5. From the *leaves* (8 to 10 ft. long) mats and baskets are made.

In desert countries the date palm is often the only tree available for the service of man. If the camel is the ship of the desert, dates are the ship's provision.

Another palm, which bears a fruit resembling the date, yields oil. The oil is crushed from the *seed*, and large quantities of it are used in the manufacture of soap and candles. It is called *palm oil.*

XXV.

SAGO AND TAPIOCA.

Sago, large and small; tapioca; grains of rice; some soaked or boiled sago.

WHAT IS SAGO?

1. Give to the children some large and small sago. Notice the shape of the grains. Show some that have been boiled. Crush some dry grains. Observe:

- (*a*) Grains of sago are round and white.
- (*b*) They can be crushed into a white powder.
- (*c*) When boiled they are like jelly.

2. Recall what grains of rice were found to be. What do such grains contain? A little plant. What would happen if they were sown? The little plant would grow. What is each grain? A seed. To speak more accurately, it contains a seed. Now, a grain of sago would not grow if it were sown. It contains no little plant. Summarize:—

- (*a*) Grains of rice or wheat grow when sown.
- (*b*) They contain little plants
- (*c*) Sago would not grow if sown.
- (*d*) Grains of sago are not seeds.

WHAT SAGO IS.

1. Sago is brought to us from countries round about the Indian Ocean. It is obtained from a kind of palm tree. Like other palms it only grows in hot countries. It is about thirty feet high. Compare with date palm—about half the height.

2. Recall the characteristics of a palm:—

- (*a*) A palm is generally a tall tree.
- (*b*) It has no branches on its tall straight stem.
- (*c*) It has a tuft of very large feathery leaves at the top. And we may add,
- (*d*) The stem is not covered with a bark.

3. The central portion of the stem of the sago palm is soft, and this is the part of the tree from which sago is made. It is not the *pith* of the tree. Palms have no pith.

HOW SAGO IS MADE.

Explain the following stages in the preparation of sago:—

1. The palm is cut down and sawn into lengths. The soft part is taken out by washing in water. After several washings the soft part subsides, and is collected in baskets made of the leaves of the palm.

2. When dried, it resembles flour, and the natives make it into bread.

3. To prepare it for our use the flour is moistened, and passed through a sieve into an iron pot over a fire. As it passes through the sieve it assumes its rounded form, and is at once dried by the heat.

4. Call attention to the boiled sago, and notice its resemblance to boiled starch. It is, in fact, mainly starch. It forms a light food, but is not very nourishing.

5. One palm will produce from 200 to 600 pounds of sago; but then the plant is destroyed in obtaining its produce, and is of no further use.

TAPIOCA.

1. Show specimens of dry and boiled tapioca. Notice the shape and resemblance to sago.

2. Tapioca is obtained from the root of a plant which grows in South America.

3. The plant is about six feet in height, and its roots are like very large parsnips.

4. The root is peeled and grated. A white substance is obtained, which is *deadly poisonous*. The water is squeezed out in long rush baskets, which become much contracted by being pulled.

5. Drying in the sun *removes all the poison*. From the white powder thus obtained the Indians make bread.

(Arrowroot is obtained from the root of another plant in a similar way.)

6. To prepare the tapioca for our use the moistened flour is baked on smooth clay plates over a fire, when it takes the form in which we are accustomed to see it.

SUMMARY.

1. Sago is made from the middle of the stem of a palm tree.
2. Tapioca is made from the poisonous root of a small shrub.

PALMS.

1. Palms are found in tropical countries, and generally grow near water.

2. They are of great service to man :—

(*a*) The date palm yields dates.
(*b*) The cocoa-nut palm ,, cocoa-nuts and oil.
(*c*) The oil palm ,, palm oil.
(*d*) The sago palm ,, sago.
(*e*) All of them ,, wood, fibres, and leaves, which serve a great variety of purposes.

XXVI.

THE OAK TREE.

The monarch of the forest.

Oak leaves, acorns, oak galls, oak bark, tannin and wood, hazel nut, deal; cylinder and cone.

ACORNS.

(If this lesson be given at a time when acorns cannot be obtained, it should begin with "Description" or "timber," and acorns should be dealt with as products.)

1. Distribute acorns to the children, ask what they are, and whence obtained. Observe :—

(*a*) Acorns grow on oak trees.
(*b*) Each acorn grows in a little cup.

2. What are acorns? The fruit of the oak. Then if we plant acorns, what may we expect? Young oak trees will grow from them.

3. Cut through the skin, and lead children to observe:—

   (*a*) An acorn has an outer tough skin.
   (*b*) Inside there is a kernel.

4. Compare this structure with the hazel nut. An acorn is a *nut*. Split the kernel:—

   (*a*) The kernel splits into two parts.
   (*b*) The young plant is seen inside at the top.

5. Let the acorns be tasted. They are not pleasant. The acorns of our oak trees are not used for human food, but pigs feed upon them and become very fat.

DESCRIPTION OF THE TREE.

1. On what kind of tree do acorns grow? Get the children to give as much in the way of description as possible:—

   (*a*) The oak is a large tree with a thick trunk.
   (*b*) The trunk is much knotted or gnarled, and the branches spread out.
   (*c*) The trunk is broader at the base than above.

2. Show with a cone and cylinder (models) that the broader the base is compared with the part above the more difficult is it for the object to be overturned. Hence the form of the oak trunk enables it to stand more firmly. It is seldom an oak tree is blown up by the roots. The roots, however, go a long way into the ground, and give it additional stability. The monarch of trees.

3. Show some oak leaves. Refer to the wearing of oak on the 29th of May. Observe:—

   (*a*) The oak leaf has a wavy edge, or rounded points.
   (*b*) It is broader at the top.
   (*c*) The leaves fall from the tree in the autumn, but new ones grow in the spring.

THE FLOWERS.

1. As the oak bears fruit it may be supposed that it will have flowers also. These are not generally noticed because they are so small. They appear early in the spring, almost before the leaves.

2. The flowers are of two kinds. One kind which does not produce fruit itself grows in little strings or *catkins*. These *catkins* may often be found lying on the ground under the tree after a shower or strong wind. The flowers of the catkins produce yellow dust, which must be carried by the wind to the other flowers to make them produce fruit. Recall the similar case of the date palm. In the case of the oak, both kinds of flowers grow on the same tree.

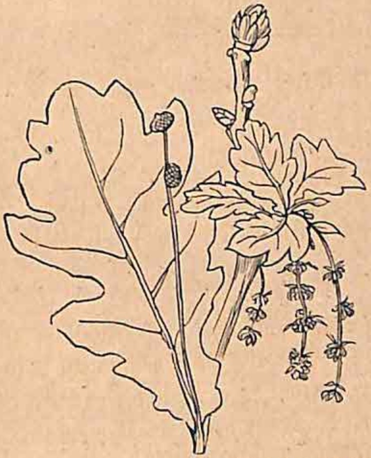

Fig. 33. Oak leaves, catkins, pistillate flowers and acorns.

XXVI. THE OAK TREE (*continued*).

TIMBER.

1. Lead the children to give the following information:—
   - (*a*) Trees give us wood.
   - (*b*) This wood obtained from the trunk and large branches.
   - (*c*) The trees are felled and those parts sawn up.
   - (*d*) Such wood is called timber.

2. Show some oak wood in which the grain is clearly seen. Compare the weight of a piece of oak with a similar piece of deal. Let the children try to separate the fibres. Deal splinters easily. Illustrate. Hence we know oak wood:—

(*a*) By its peculiar grain.
(*b*) By its heaviness.
(*c*) By its hardness and solidity.

3. Oak wood was formerly used for ship-building. Then the ships were called "the wooden walls of Old England." Nelson fought in such a ship. Show how suitable it was for that service. So close are its fibres that it is almost impervious to water. Ask for other uses:—

(*a*) Oak wood was formerly used for ship-building.
(*b*) Beams and floors were made of it.
(*c*) It was and is still used for carving.

4. The wood seems to become heavier and harder with age. Some of it has lasted as long as 600 years. Wherever great durability is required it is still used; but it is now scarce.

5. An oak tree must grow 100 years before the tree has formed the best timber. Some have lived 300 years.

THE BARK.

1. Question on the purpose of bark:—

(*a*) Trunks of trees are generally protected by bark.
(*b*) This bark keeps the sap from being dried up.
(*c*) It also prevents injury to the inner parts.

2. Show some oak bark. It is used for tanning leather; that is, for turning the skins of horses and cows into leather. There is something in the bark which causes the skins to *shrink* and to become thick and tough.

3. This something is called *tannin*. Show a specimen.

4. Show cork in the form of bark. This is the bark of a kind of oak that grows in the south of Europe. Corks are cut from it.

OAK APPLES.

1. Most children who have seen oak trees are acquainted with oak apples. Show some. Observe:—

- (*a*) Oak apples are quite round.
- (*b*) When old they are brown, and have a little hole in one side.

2. Though called apples, they are not fruit. The acorns are the fruit. If you have a green one, cut it open. A little grub will be found in the centre.

3. Oak apples are the *nests* of an *insect*. This insect bores a little hole in the bark or leaves of the oak and there lays its eggs. The sap of the tree forms a growth round the eggs, which results in the oak apples.

4. When the eggs are hatched the little grub comes out, and when ready, eats its way out. Hence the little hole.

5. Oak apples contain tannin, which is generally obtained from them. (Show some.) From some kinds of oak trees the apples (called oak galls) are used for making ink.

XXVII.

THE PINE TREE.

Pine leaves (Scotch "fir"); pitch pine; turpentine or oil of pine, tar, pitch; fir cones; alcohol, cotton wool, water.

RESIN AND TURPENTINE.

1. Most children will have some acquaintance with either or both of these substances. Show some turpentine, let children smell it; tell its name. Soak some cotton wool with turpentine and burn it:—

- (*a*) Turpentine is a colourless fluid.
- (*b*) It has a strong odour.
- (*c*) It burns readily with a yellow flame, giving off much black smoke.

2. Show some resin; give its name. Break a piece, notice its odour. Lead children to tell:—

- (*a*) Resin is a solid, of a brownish yellow colour.
- (*b*) It is very brittle.
- (*c*) It has an odour like that of turpentine.

3. Put a small piece in water, and some in alcohol. Heat some in an iron spoon. Burn a piece. Lead children to observe :—

- (*a*) Resin is not dissolved in water.
- (*b*) It is dissolved in alcohol. It is therefore said to be soluble in alcohol but not in water.
- (*c*) It melts very readily.
- (*d*) It burns with a bright flame, giving off much black smoke.

4. Both turpentine and resin are obtained from the same source.

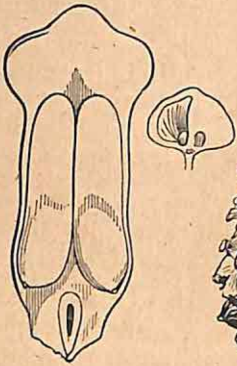

Fig. 34. Winged seeds of pine.

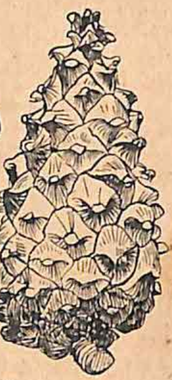

Fig. 35. Cone of Scotch pine.

CONES.

Show some pine cones. They are called *cones* on account of their shape. Whence are they obtained? From trees. Examine their structure; take off the scales, or press them back and expose small winged bodies; these are seeds. What can be the purpose of the wings? Suppose when they dropped from the cones there were no wings! They would fall to the ground. But having wings, what then would happen? They would be blown about more easily. That is the purpose of the wings, to enable the seeds to be carried further away from the parent tree. The seeds, if planted, would grow and produce young trees. What then is the cone which holds these seeds? The fruit. Summarize :—

(*a*) Pine cones are made up of overlapping scales.
(*b*) Each scale has seeds on its inner or upper side.
(*c*) Each seed has a long wing.
(*d*) The wing enables the seed to be carried away by the wind.
(*e*) Pine cones are fruit.

LEAVES AND FLOWERS.

1. Show a branch of pine bearing leaves. This is the kind of tree from which we get the cones. Observe:—

(*a*) The leaves are like needles.
(*b*) The bark is rough.
(*c*) Both leaves and bark are sticky when handled.
(*d*) Both have the odour of *turpentine* or *resin*.

2. Trees bearing such leaves and fruit are called *pines*. There are many kinds of pine, but the best known in England are the Scotch pine (or "fir") and the larch. They have thick tall trunks, and their leaves are evergreen. (The leaves of the larch fall off annually.)

3. A pine tree has two kinds of flowers, like the oak—one kind produces the cone, the other only yellow dust, which must be blown on to the little cones. These little cones are not ripe until the third year after they have made their appearance.

4. A forest of pines has a very dark and sombre appearance.

PRODUCTS OF PINE TREES.

1. Let the children, after handling the leaves and stems, notice the state of their fingers. They will have become sticky, and will smell strongly of turpentine and resin.

2. Show some pitch-pine wood. Notice its odour. Burn a piece. Lead children to observe:—

(*a*) Pine leaves and stems have an odour like that of turpentine.
(*b*) Pitch-pine wood has a similar smell.
(*c*) It burns very readily.

3. It will be no surprise to learn that resin and turpentine are obtained from pine trees. When the trees are growing, cuts are made in the wood, and boxes placed underneath. Turpentine flows out freely. This is distilled and yields:—

(*a*) Resin.
(*b*) Oil of pine, or oil of turpentine.

4. The pine yields other products. Sometimes trees are felled and cut into pieces. These are piled up over a hole dug in the earth and covered with clay. The wood is then set fire to, and burns very slowly. A black liquid runs from it and collects in the hole beneath. This is *tar*. Show specimen. When tar is distilled it yields *pitch*. Show specimen. The burnt wood left is *charcoal*.

5. Review:—

(*a*) The living tree yields turpentine, which when distilled gives resin and oil of turpentine.
(*b*) The tree burnt under earth gives tar and charcoal
(*c*) The tar distilled gives pitch.

6. The insolubility of resin has been noticed. Draw attention to the same property in pitch, especially noticeable when an attempt is made to wash it from the hands with cold water. Hence explain the use of pitch and tar to keep out water.

7. The pine tree also furnishes timber. It has been called the "builders' timber," because it is so much used in house building.

Deal is a name given to a kind of pine when sawn into boards of a certain size.

Red and *yellow* pine are much used.

The *trunks* make masts for ships.

8. The wood being full of turpentine resists water.

9. Pines grow better in cold than in warm countries.

XXVIII.

TEA.

Green and black tea; some leaves that have been infused; tannin. Picture of a Chinese. Map.

WHAT TEA IS.

1. All children know something of tea. Refer to its general use. Show specimens of black and green tea. Notice:—

(*a*) Some tea is black, some green
(*b*) It all consists of small dried bits.

2. How is tea used? Boiling water is poured on it. The liquid is drunk, something is left. Such a liquid is called a beverage. *Tea leaves* remain.

3. Show some such leaves, spread some out and show they are leaves of a plant. Place some to dry, and they will tend to resume their curled-up form.

4. Tea then consists of the leaves of a plant. This plant grows in China, India, and Ceylon.

CULTIVATION OF TEA PLANT.

1. Describe briefly the country in which tea is grown. Suppose we could go to China, we should find the hill-sides covered with shrubs from three to six feet in height—some as small as a gooseberry bush, others as large as a good holly tree. Busy amongst these bushes we should see numbers of men, women, and children, all very strange in appearance to us—with yellow beardless faces, and hair in long plaits down their backs. Show a picture of a Chinese.

2. In one part of the year we should see these people very busily planting and watering, at another time plucking the leaves of the shrubs and carrying them home in baskets.

These plants are tea plants; the leaves are being gathered to be made into the state in which we buy them as *tea* from the shop.

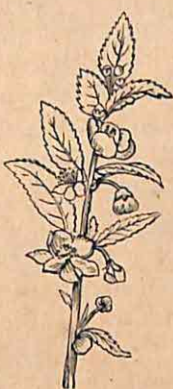

Fig. 36. Tea plant. Branch, with flowers and leaves.

PREPARATION.

1. The leaves are taken to the tea-house, and treated as follows:—

- (*a*) Set to stand in the sun for a short time.
- (*b*) Heated a little in an iron pan.
- (*c*) Rolled about on a table with the hands.
- (*d*) Heated again in the pan, all the time being rolled about.
- (*e*) Carefully picked; all unsuitable leaves taken out. Thus they are brought into the dried rolled-up condition in which we buy them.

2. The above is the general plan, but there are various modifications of it. *Black* and *green* teas are produced simply by *different methods of drying.* Sometimes tea is *coloured* green by poisonous substances being added during the drying. The best tea is made from the youngest leaves.

3. To make 80 lbs. of tea per day there are needed 25 gatherers and 10 sorters.

4. The tea has then to be brought over the seas, and it is exported in lead-lined boxes. Why? Suppose tea be kept in paper or in an open box. It loses all its *aroma* or pleasant *odour* and *flavour*.

HISTORY.

1. Tea was first brought to England about 200 years ago (1666), from Holland. (Not grown in Holland, but brought there by Dutch merchants.)

2. People did not know how to use it; they threw away the liquor and ate the leaves; hence they then often invited their friends, not to a cup, but to a "dish of tea."

3. Now as much as 140,000,000 pounds of tea are brought to England annually, and more than half of this comes from India and Ceylon.

THE INFUSION OF TEA.

1. Question on the "making" of the beverage; teach the term *infusion*. Tea is not *brewed* as is sometimes said. Bring out the following points:—

(*a*) *Boiling* water should be used.
(*b*) After a time the water has become brownish in colour.
(*c*) This brown liquid has rather a bitter taste. Sugar and milk are used to *modify* it. The Russians use lemon juice, the Chinese nothing.
(*d*) If the infusion remain for 15 or 20 minutes, it becomes blackish, and has a different taste.

2. The cause of this change is the *tannin* which the leaves contain, but which is not at first extracted. Recall what was said of tannin in the lesson on the Oak Tree. *Tannin* in solution will turn an *iron spoon black*. Its effect is felt in the mouth in causing a roughness. This is the same kind of action as takes place in the tanning of leather. Tea, then, should not be drunk when the tannin has been extracted. Strong tea is injurious to the nerves; but tea rightly made is both a pleasant and a cheering beverage.

XXIX.

COFFEE.

Coffee berries roasted and unroasted, ground coffee, chicory; laurel leaves, picture of plant, map.

COFFEE BERRIES.

1. Refer to the last lesson and the term beverage. What other similar beverages have we? Coffee and cocoa.

2. From what is coffee made? Show some ground coffee and lead the children to tell :—

(*a*) Coffee is a brown powder.
(*b*) It has an *aromatic* odour.
(*c*) It is rather bitter to the taste.

3. How is the brown powder obtained? From coffee berries. Show some berries; observe smell and taste; grind one.

(*a*) Coffee has the same smell and taste as the coffee "berry."
(*b*) When ground the "berry" becomes coffee.

4. Show some unroasted berries or beans, and compare and contrast them with the others :—

(*a*) These beans are *green*, the others *brown*.
(*b*) They are both alike in shape.
(*c*) The green ones have no aromatic odour.

5. The brown beans have once been green, but they have been roasted. They were roasted in a hot revolving cylinder. (Illustrate the action.) Great care had to be taken not to burn them. In roasting they acquired their odour and flavour.

6. Coffee exposed to the air soon loses its odour, it should therefore be kept in air-tight tins.

7. It is on account of its flavour that coffee is liked. But it is often badly made in England. The Turks and Arabs know best how to make coffee. In England, often too much water is used, or the water is not boiling, or water is added afterwards; any one of which is sufficient to destroy its flavour. Coffee properly made is a stimulating beverage, and the best in cold weather, as tea is in hot.

WHAT IS COFFEE?

1. Now let us find out what these green berries or beans are. Observe them more closely :—

(*a*) They are hemispherical in shape.
(*b*) Two fitted together look like one split open.

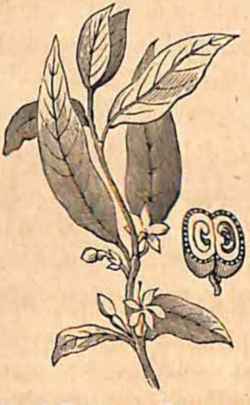

Fig. 37. Coffee plant. Flowers and leaves, fruit in section.

2. These are two seeds taken out of a berry. They come to us as you now see them. But if we could go to Arabia or Ceylon, where the berries are grown, we should see plantations of shrubs three to six feet high, with leaves like those of the laurel. Some morning these would be so covered with white flowers that it would look as if snow had fallen during the night.

THE REAL BERRY.

1. Soon these flowers disappear, and berries grow in their stead. Each berry is of about the size of a cherry. It contains two seeds which are surrounded by a juicy pulp.

2. What now is the first operation? Gathering the fruit. And the next? Removing the pulp from the seeds. This is done by first drying the fruit and then crushing it between rollers. The dried pulp comes away in the form of husk which is winnowed from the seeds. These seeds are our own *green coffee "berries."*

3. In growing plums, which part should we prefer to be larger, the pulp or the stone? The pulp. In growing coffee, which do you think the coffee planter likes to be large? The seeds. He therefore gives his plants little water.

COFFEE AND CHICORY.

1. What is often sold mixed with coffee? Chicory. Show some chicory, and lead children to observe :—

(*a*) Chicory looks like ground coffee.
(*b*) It has not the aromatic odour of coffee.

2. Chicory is obtained by drying, roasting, and grinding the root of the chicory plant, which grows wild in many parts of England. It is mixed with coffee to make the coffee cheaper, and to give it a darker colour and stronger taste.

HOW TO DETECT THE PRESENCE OF CHICORY.

1. Perform these two little experiments :—

(*a*) Take a tumbler of clear water; add a teaspoonful of pure coffee; stir, and let it subside.
(*b*) To another tumbler of water, add a teaspoonful of a mixture of chicory and coffee, and treat as above.

2. It will be found that the water in the second tumbler has acquired a yellowish tinge; hence:—

(*a*) Chicory imparts a yellowish tinge to cold water; coffee does not.
(*b*) To test the genuineness of coffee, put a teaspoonful into a tumbler of clear cold water.
(*c*) If no yellow colour follows, the coffee is free from chicory.

XXX.

COCOA AND CHOCOLATE.

Prepared cocoa, cocoa nibs; beans and pod, or a picture of them; chocolate and chocolate creams; picture of the plant.

COCOA.

1. Refer to the subject of beverages, and recall one mentioned at the beginning of the last lesson. Show some cocoa and lead children to give its properties:—

(*a*) Cocoa is a fine powder of a brownish colour.
(*b*) It has a slight bitterness.
(*c*) It is milder than coffee.

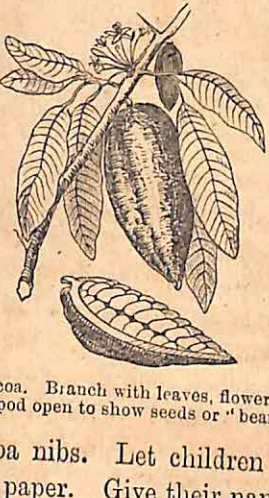

Fig. 38. Cocoa. Branch with leaves, flowers, and fruit. One pod open to show seeds or "beans."

2. Show some cocoa nibs. Let children taste. Crush some on a piece of blotting paper. Give their name:—

(*a*) Cocoa nibs taste like cocoa
(*b*) When crushed they look like cocoa.
(*c*) They contain oil.

3. These nibs are obtained from the crushed beans of a plant that grows in America.

THE COCOA PLANT, OR CACAO.

1. Show a picture of the plant. Notice :—
   (*a*) It has large laurel-like leaves.
   (*b*) Flowers and fruit grow at the same time.

2. The fruit is large and fleshy, about six inches in length, and pointed at each end. Inside this fruit there are from five to twenty seeds or *beans*. The fruit is either eaten in its juicy state, or roasted for making *cocoa*. This is prepared from the seeds, which are of about the size of a Windsor bean.

3. The name of this plant is *cacao*, and has no relation whatever to the cocoa-nut tree, which is a palm.

PREPARATION OF COCOA.

1. Recall what was found out about the nibs. They contain oil. To many people this oil is not pleasant; it must be taken out.

2. The process of preparation then is :—
   (*a*) Crushing the beans.
   (*b*) Removing the husk from the nibs (some people use the nibs without further preparation).
   (*c*) Grinding the nibs.
   (*d*) Extracting the oil, which afterwards looks like butter.

3. So far pure cocoa has been prepared. Some kinds have an addition of sugar or starch.

CHOCOLATE.

1. Show some chocolate. Observe :—
   (*a*) Chocolate is in hard cakes.
   (*b*) It is like cocoa in taste, but sweeter.

2. Chocolate is made from the ground nibs without the extraction of the oil, and with the addition of sugar and vanilla.

3. In France and other countries, chocolate is made into a beverage. Chocolate creams have only chocolate on the outside.

4. Both *cocoa* and *chocolate* are more *nourishing* beverages than either tea or coffee.

XXXI.

COTTON.

Calico, cotton wool, sewing cotton; cotton seed, oil and oil cake; cotton pod; picture; some common seeds bearing down as the thistle or willow herb. Map.

CALICO.

1. Give each child a small piece of coarse calico. Lead to the following observations :—

   (*a*) Calico is made of threads.
   (*b*) The threads lie in two directions, one set crossing the other, as in basket work.
   (*c*) Such work is said to be *woven*.

2. Let each child take a single thread and separate it into fibres, until it is reduced to a wool. Notice :—

   (*a*) Each thread consists of very fine fibres.
   (*b*) When separated, these look like wool.

3. Lead to the following conclusions :—

   (*a*) Calico has been woven from *threads*.
   (*b*) The threads have been spun from a kind of *wool*.

4. Show the same with sewing cotton. Both are made from a kind of wool called cotton. Show some cotton wool.

TREE WOOL.

1. This wool comes to us from America, Egypt, and India; there it grows on trees. Hence we may call it tree wool.

2. Lead the children to imagine an American cotton plantation—the hot climate, too hot for white people, so black people (negroes) are employed; the bushes about the height of a man's shoulder; the flowers somewhat like wild roses; the fruit, a dry pod or *capsule*.

3. What do you suppose this capsule will contain? Seeds. Yes, but there is something more. Some morning, early, it is

discovered that several capsules have burst, and a quantity of wool, just like this cotton wool, is hanging from each. This is the cotton which is sent to us. The seeds lie in it.

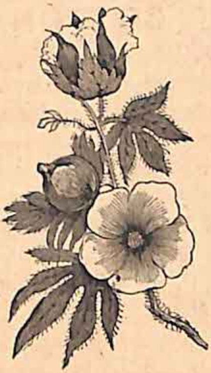

Fig. 89. Branch of cotton plant. One capsule has burst, showing cotton.

4. Now what can be the use of the wool in the capsule? Show some thistledown attached to seeds. Blow some of it, and show how easily the seed is carried away; without the down the seed would not be carried so far. Then what purpose does the down serve? And what the cotton? Summarize:—

(*a*) The fruit of the cotton tree is a capsule.
(*b*) The seeds are embedded in wool.
(*c*) This wool would help to scatter the seeds far from the parent plant.
(*d*) Before that can happen it is gathered.

THE COTTON HARVEST.

1. A cotton plantation is a very pretty sight when the cotton is ripe for gathering—dark-green leaves, and snowy white balls amongst them.

2. The wool or cotton must be gathered at once. Rain would spoil it, the sun would affect its colour. It is therefore gathered before sunrise.

3. The negro workers go out and carefully gather the cotton, leaving the capsule, for broken pieces of it would be very

troublesome amongst the cotton. As it is, there is something to be separated—the seeds. This separation is very tedious, especially when done by hand; but it is oftener done by machinery.

4. Summarize :—

(a) Wool and seeds are gathered together.
(b) The seeds are separated from the wool.
(c) The wool comes to us as raw cotton.
(d) From the raw cotton we spin threads.
(e) From the threads or yarn, calico is woven.

MANUFACTURE.

1. Cotton weaving is chiefly carried on in Lancashire; and to this country raw cotton is brought from the places already named.

2. Lancashire has a damp climate; much rain falls there. Besides this, cotton mills are generally placed in valleys, where the air contains much moisture.

3. Were spinning and weaving to be carried on in a dry air, much trouble would be caused by the snapping of threads. Hence the dampness of the atmosphere is a great help.

THE SEEDS.

1. The seeds of the cotton plant are found to be useful. They are ground and pressed, and an oil, called cotton-seed oil, is squeezed out of them. Show some oil. It is often sold for olive oil.

2. The part left after the extraction of the oil, is in the form of cakes, and is used for feeding cattle. It is called cotton, or oil cake. Compare with mustard cake.

XXXII.

FLAX.

Linseed, oil, meal, oil cake; linen, cambric, thread; bast, dead twigs of lime; flax stalks and flax (undressed). Sow some linseed in the spring, in the summer the blue flowers will appear.

LINSEED AND ITS PRODUCTS.

1. Give linseed to children; question as to its name and common uses. Lead to the following:—

   (*a*) Linseeds are brown and shiny.
   (*b*) In shape, they are longer than broad, pointed and flat.

2. Grind up some seeds. Compare with linseed meal. Notice the paper in which the meal has been wrapped. It is oily.

   (*a*) Linseed is often ground into meal.
   (*b*) The meal makes the paper oily.
   (*c*) Therefore linseed contains oil.

3. Show linseed oil. It is used by painters for mixing their paints.

4. To extract the oil, the seeds are crushed. What is left after the extraction of the oil is in the form of large cakes, and is called *oil cake*. Show a piece, and compare with cotton cake. It is used for feeding cattle.

THE FLAX PLANT.

1. But where do we get this linseed from? If *seed*, it must be obtained from a plant. Let us sow some seeds, and we shall find out. If you have some that have been sown, show the plants; if not, the red flax of our flower gardens will illustrate everything but the colour, which is *red*, instead of *blue*. Lead to the following:—

   (*a*) Linseed is the seed of the flax plant.
   (*b*) The plant is slender, and bears blue flowers.
   (*c*) From linseed are obtained *meal*, *oil*, and *oil cake*.

2. Flax grows best in a damp climate. It thrives particularly well in the North of Ireland.

LINEN.

1. *Flax is not grown for its seeds only. It yields a more* valuable product.

2. Give children pieces of linen; compare with calico, and notice:—

(*a*) Linen is like calico, in being made of threads woven together.
(*b*) It differs in being smoother and more shiny.

3. Give examples of things made of linen—collars, pocket-handkerchiefs (cambric), white table cloths.

4. Let the children separate the threads of the linen and reduce them to fibres. This fibrous material is called *lint.* From it *linen* is made. Notice the resemblance in the words *lint*, *linen* and *linseed* or *lintseed.*

5. From this comparison it will be evident that *linseed* and *lint* have some connection. Linseed is obtained from the flax plant; then it would seem that *lint* is also got from the same source. This is so.

6. Lint is used by doctors for dressing wounds, and linen is always better than calico for such a purpose.

7. Linen is the oldest fabric known. It was woven before wool, silk, or cotton.

THE FIBRE.

1. Now we must find out what part of the flax plant gives us these fine fibres. It is not the fruit, as in the cotton, for the seeds have nothing but a chaffy covering.

2. Give children some dead twigs of lime. Let them examine these carefully; pull off the outer, then the inner, bark. Observe:—

(*a*) There is a hard woody part.
(*b*) A light-brown inner bark.
(*c*) A darker outer bark.

3. The inner bark is called *bast.* Show some of the kind used by gardeners to tie up plants. Notice:—

(*a*) Bast is inner bark,
(*b*) It is fibrous, and can be torn off in strips.

4. *Now, it is the bast* of the flax stems from which linen is made. If you have flax stalks, examine and show the bast.

MANUFACTURE.

The following are the chief stages :—

1. The flax is cut down, and the stalks soaked in water.
2. The stalks are beaten to break the woody part.
3. The broken bits of wood are removed by the material being drawn across a spiked board.
4. Fibre is now left, and it is spun into (*a*) sewing thread, (*b*) thread for making linen. Show some sewing thread. Compare for strength with cotton.
5. Bleaching, or making white.
6. Weaving.

g. 39. Flax. Stem bearing leaves and flowers

XXXIII.

CAOUTCHOUC.

(INDIA RUBBER.)

India rubber; hot and cold water; mackintosh; iron spoon, piece of sulphur; naptha; vulcanite.

INDIA RUBBER—ITS PROPERTIES.

1. *Elastic.* Let children experiment with a piece of India rubber; bend it, compress it, stretch it. Do the same with "elastic," steel, sponge, &c. Lead to the following conclusions:—

   (*a*) When India Rubber is stretched, bent, or compressed, it very readily takes again its former shape.
   (*b*) A piece of steel, or a sponge, shows the same property, but not so well.
   (*c*) Such bodies are said to be *elastic.*

2. *Waterproof.* Take a piece of mackintosh or India rubber cloth; notice the strong odour. Compare the odour of India rubber; explain that mackintosh is made of india rubber and cloth. Form a trough with a piece, and pour in water.

   (*a*) India rubber does not let water pass through it.
   (*b*) It is therefore said to be water *proof.*

3. *Insoluble.* Put a piece into hot water, and another into cold; observe:—

   (*a*) India rubber is not affected by cold water.
   (*b*) It is only softened a little by hot water.
   (*c*) It is therefore *insoluble* in water.

4. *Inflammable.* Place a piece in an iron spoon and try to melt it. Note the result. Explain the term inflammable (able to be brought into a state of flaming or burning).

   (*a*) India rubber does not *melt* freely.
   (*b*) When heated it turns to liquid, but directly begins to burn.
   (*c*) It is said to be *inflammable.*

Summarize the properties :--

(*a*) Elastic.
(*b*) Waterproof.
(*c*) Insoluble in water.
(*d*) Inflammable.

USES.

1. Question on the general uses to which it is put, and show how its peculiar properties fit it for those uses.

(*a*) Its elasticity fits it to be used for *balls*, *tubing*, &c.
(*b*) Its insolubility and power of resisting water fit it for being used in contact with water—water bottles, mackintosh, &c.
(*c*) Its moderate hardness and elasticity (pliability) for cleaning pencil marks from paper.

When pencil marks are cleaned off, a thin surface of the paper is removed.

2. It is called India rubber, because it is used for *rubbing*, and it was first obtained from the *Indians*.

HOW IT IS MANIPULATED.

1. Recall what was found out with regard to its insolubility in water, and the readiness with which it burns when an attempt is made to melt it. How then can pieces be fastened together? How can it be manufactured into India rubber clothing?

2. What happened when we placed India rubber in hot water? The rubber was softened. Show then that when in this condition pieces may be joined together.

3. Dissolve a piece in naptha. When dissolved, it can be spread out over cloth or pressed into it. Certain acids also dissolve it.

4. India rubber is also used in another way. It is beaten out with sulphur to produce vulcanite. Show some sulphur and some vulcanite.

CAOUTCHOUC—WHAT IT IS.

1. India rubber comes to us from South America. There it is obtained by the Indians from certain trees. It is called caoutchouc (*koo-chooc*).

2. Caoutchouc is the milky juice of these trees. To get it out in great quantities, cuts are made in the bark. It very quickly solidifies. Compare with the milky juice of the dandelion, sow-thistle and lettuce.

3. While still milky, the juice is spread out in layers on clay; when one layer is dry, another is spread over it. Drying it in smoke gives it a black colour. When *pure*, it is white, and has no smell.

GUTTA PERCHA resembles caoutchouc in its properties and uses; but is obtained from a different tree, and is brought from the East.

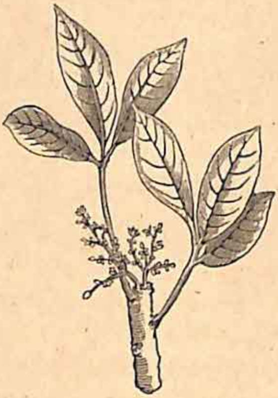

Fig. 40. Branch of India rubber or caoutchouc tree.

A SUMMARY

Of the plants mentioned in this book, and the part they render in the service of mankind.

I. AS FOOD.

1. *Fruit*—Apple, pear, plum, cherry, peach, grape, gooseberry, currants, orange, strawberry, raspberry, bramble, kidney bean, wheat, oats, barley, rye, rice, maize, date.
2. *Seeds*—Almond, pea, bean, mustard, coffee, cacao, cocoa-nut.
3. *Stems*—Potato, sugar cane, sago, mustard.
4. *Leaves*—Cabbage, onion, tea.
5. *Roots*—Turnip, carrot, tapioca, chicory.

II IN OTHER WAYS.

1. *Oil* is obtained from the orange, almond, mustard seed, cocoa-nut, oil palm, cacao, cotton-seed and linseed.
2. *Wood* is furnished by the oak, pine, bamboo, the cocoa-nut and date palms.
3. *Clothing* is made from the inner bark fibres of flax, and the wool contained in the fruit of the cotton.
4. *Wheat* and other grasses supply straw.
   The oak gives timber, charcoal, bark, tannin.
   The pine gives turpentine, resin, pitch, tar, timber.
   The cocoa-nut palm gives cocoa-nuts, wood, fibres for mat-making, leaves for baskets, &c.
   The India rubber trees give their juice as caoutchouc.
   Flax gives linseed, oil, and linen.

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